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PACKAGING ADHESIVES

- *UV LED Curing*
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- *Pressure-Sensitive Adhesive Selection*

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VOLUME 28, ISSUE 5

FEATURES

Case Study: Successfully Navigating a Food and Beverage Packaging Change

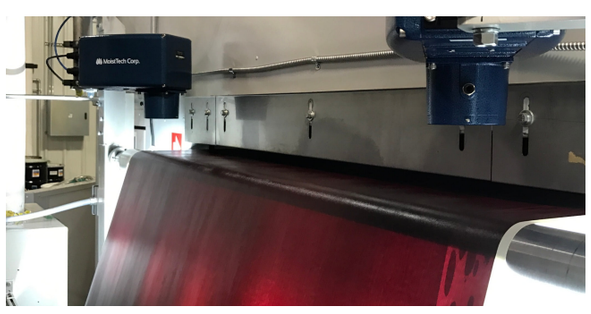
How did a national baby-food manufacturer determine the best adhesive solution for an updated label design?

Sustainable Packaging: An Opportunity to Stay Competitive in a Post-COVID World

A recent survey explores the trend toward sustainable packaging and possible ramifications for decision makers in the packaging sector.

Developing Sustainable Packaging Solutions

Recycling and recyclability are key factors that sustainable packaging producer EcoEnclose considers when developing ecommerce packaging solutions.



Lean Manufacturing: Minimizing Costs with Moisture and Coat Weight Control

Converting process efficiency is often affected by variations in coat weight, inefficient moisture control, and thickness and/or temperature issues.

Modernizing Assembly Lines with UV LED Curing

Adhesive bonding, sealing, and coating processes in factory assembly lines are rapidly upgrading to UV LED curing technology.

Advancing Silicone-Based Medical Adhesives

A new adhesive for wearable medical devices enhances patient comfort while providing engineers confidence about wear duration.

Better Bonding: Simplifying Pressure-Sensitive Adhesive Selection

Taking a systematic approach and using selection tools available from adhesive manufacturers can streamline the pressure-sensitive adhesive selection process and help ensure strong bonding in each application.

How Does Mineral Selection Impact Water-Based Adhesives?

The selection and control of the physical properties of minerals are critical in improving an adhesive's performance.

DEPARTMENTS

COLUMNISTS

FROM THE EDITOR

>> Susan Sutton, editor-in-chief

THE COMPLETE PACKAGE

Brands are exploring sustainable packaging as a means of increasing their appeal to environmentally conscious consumers.

Brands have long relied on their products' packaging to draw the consumers' eye and entice them to consider a purchase. But packaging has evolved beyond eye-catching graphics to encompass so much more, particularly as consumers continue to explore "green" products and services with the goal of helping to address climate change.

Customers today are evaluating not only the product before they purchase, but also the packaging that the product is contained (and often, shipped) in—seeking a "complete package" of ideal product characteristics coupled with environmentally friendly packaging. tesa tape recently surveyed decision makers at consumer packaged goods companies to explore how they view packaging in terms of their sustainability goals.

"Four out of five told us that staying ahead of the curve for sustainable packaging will help them remain competitive in the years ahead as consumers and large retailers increasingly demand sustainable products," writes Steve Molinets. To learn more about these findings, read Steve's article, "Sustainable Packaging: An Opportunity to Stay Competitive in a Post-COVID World," in this issue.

Speaking of packaging, I want to make sure you have the opportunity to receive **ASI** content in the "packages" that work best for you! You can subscribe to our monthly eMagazine (free to qualified individuals), as well as both of our eNewsletters, at www.adhesivesmag.com/subscribe. If you prefer visiting the website, you'll be asked to enter a few details in a brief, one-time site registration that grants you unlimited access to our annual **ASI** Top 20 listing of the leading worldwide manufacturers of adhesives and sealants, as well as all feature articles, columns, news stories, new products, and much more.

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Susan Sutton is Editor-in-Chief, Integrated Media, of ASI magazine. If you wish to send a letter to the editor, please email suttons@bnpmedia.com. Letters must include the sender's address, phone number, and email address, when possible. Letters may be edited for space and clarity.

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>> By Michael Rezai, Senior Consultant, The ChemQuest Group

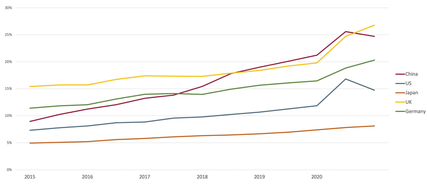
COVID-19 IMPACT ON GLOBAL SHIPPING AND PACKAGING DYNAMICS

The continued transition away from brick-and-mortar to ecommerce brings demand for packaging innovations that enable faster delivery and better content protection from shock or temperature variations.

The shift from brick-and-mortar to digital shopping had been under way for some time when the COVID-19 pandemic hit. Since 2017, ecommerce revenues have risen from an estimated $1.4 trillion to $2.4 trillion, or about 2.7% of global output.

China is the largest market, followed by the U.S., Japan, the UK, and Germany. The pandemic has further accelerated this shift. The restrictions on mobility imposed to fight the spread of the virus led to a surge in online demand for many goods and services. As individuals stayed home, the online share of retail sales in China, Germany, the UK, and U.S. rose by 4-7 percentage points in 2020. In China and the U.S., the share has recently fallen again but remains well above its pre-pandemic level.

Figure 1. The share of ecommerce in overall retail sales has spiked. (Sources: JP Morgan, Statista.)



COVID-19 has accelerated the shift toward digital living and ecommerce. As ecommerce continues to gain prominence, more emphasis is being placed on packaging's role in this new era. With this transition comes demand for packaging innovations that enable faster delivery and better content protection from shock or temperature variations.

Packaging Supply Chain

COVID-19 represents a game changer for the packaging industry. The pandemic has suddenly created among consumers a general need to feel safer from diseases, particularly those that are virally transmitted. Consumers are required to spend more time at home and less time socializing in public. Safety and hygiene have suddenly become paramount, and digital convenience has also risen in importance.

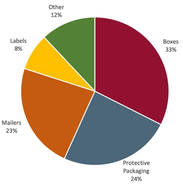
The pandemic has increased not only packaging demand but its prominence. Packaging has gained value in the eye of the shopper, which, in turn, drives innovation and may improve margins for the packaging industry.

Specifically, consumers greatly value packaging's preservation properties, the hygiene and safety offered by packaging against viral contamination risks, and the convenience of packaged goods delivered through ecommerce as a safer alternative to in-store shopping. Thus, opportunity in packaging innovation can serve consumers in the future in three main ways:

- Improving hygiene and safety—shelf life optimization, antimicrobial packaging, smart packaging connected with contact tracing apps, and low-touch/contactless packaging
- Improving environmental sustainability—more widely recyclable packaging materials, more recycled content usage, more bio-based and compostable/biodegradable materials, and new returnable systems
- Getting ecommerce ready—new shockproof and insulation packaging, new pack formats and sizes for home or letterbox delivery, new pack formats for greater automation and turnaround, and favorable unboxing features for package recipients

Packaging material and technology advances will be a significant part of the future of packaging, with the two-pronged goal of increasing consumer engagement with a brand and augmenting the connectivity to the product itself. For example, radio frequency identification (RFID) can allow tracking on a package and sends signals to a smartphone. This technology also will allow brands to monitor certain conditions during the journey, such as temperature, vibration, and security.

Figure 2. Global ecommerce packaging demand by product. (Source: Freedonia)



Packaging Adhesives

Ecommerce packaging adhesives must be compatible with the latest intricate packaging designs while remaining safe and reliable on complex commutes, factoring in cost pressure through the value chain. Adhesive manufacturers now must keep pace with both the retailer and the rapidly changing demands of consumers, such as tamper-evident seals and returns of pre-packaged goods. Adhesive manufacturers should pay attention to four potential packaging changes to be competitive in the post-COVID milieu:

Decreased Importance on Packaging Shelf Appeal
According to McKinsey & Co., some analysts speculate that using a product's packaging to attract customer interest will not be as important as it has been in traditional retail. This is because a product will not be on a shelf among many other products vying for consumer attention. Graphics and aesthetic package design may hold a lower priority in primary and secondary packaging structures.

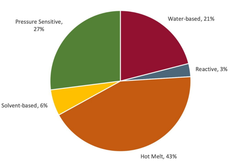
New Package Development Opportunities
Ecommerce will create an opportunity for new types of packaging to be developed. Forecast to be in demand are: packaging that uses materials durable enough for shipping process, and packaging that does not require both primary and secondary packaging to ship.

Increased Production Line Optimizations
Packaging that can be filled quickly and inexpensively on production lines will likely gain prominence. Package manufacturers will want to ensure they use materials suited for automated equipment that does not contribute to downtime or product quality issues.

Specialized Packaging Designs
Packaging developed specifically for ecommerce is also likely to make headway in upcoming years. This entails packaging that is lighter weight and smaller in size to help reduce shipping and storage costs, as well as packaging that is right-sized and uses less material to aid in sustainability initiatives.

When shopping online, the customer's first touchpoint with a brand is often its product's packaging. Adhesive manufacturers must work closely with global brand leaders to ensure that the adhesive holds the package together effectively and can easily be applied neatly so as not to interfere with the first impression of the end product.

Figure 3. Flexible packaging adhesives by technology in North American paper, board, and related products. (Source: The ChemQuest Group.)



The focus is now also on more sustainable ecommerce packaging solutions. A news report revealed that in 2021, not only will 67% more Americans shop online but 68% will look for plastic-free packaging. Natural polymers are ranked as the number-one disruptive technology, followed by hot-melt adhesives emerging on the market with bio-based content of 25-75%. It is considered to have significant potential in fast food/ grocery packaging due to sustainability implications and consumer behavior.

Understanding Future Trends

Looking to 2024, all consumer goods industries and their packaging should boast a positive CAGR as the effects of the COVID-19 pandemic recede and the economy slowly recovers. Beyond 2021, the impact of high government and private sector debt, coupled with a slowing economy (after pent-up demand has receded), will likely slow growth.

Access to market research by end market will allow adhesives stakeholders to assess by market segment. Factors such as product demand, technology share, material performance, growth drivers, and unmet market needs will help better target profitable innovative R&D programs.

Michael Rezai serves as senior consultant for The ChemQuest Group. For more information, call (513) 469-7555, email info@chemquest.com, or visit www.chemquest.com.

CASE STUDY

SUCCESSFULLY NAVIGATING A FOOD AND BEVERAGE PACKAGING CHANGE

How did a national baby-food manufacturer determine the best adhesive solution for an updated label design?

By Pete Turner and Nick Vogt, Application Specialists, APPLIED Adhesives

Operating in the food and beverage industry requires careful considerations for packaging—from food safety to aesthetics. Therefore, when it is time to make an update to packaging, it is important to revisit key factors related to adhesion, including:

- Field performance
- Resistance to hot and cold
- Shelf appeal
- Line performance and material processing
- Changes in cost due to label updates

Familiar with these considerations, a national baby-food manufacturer was considering a packaging change—from paper labels to clear poly labels on its recyclable glass jars. In updating the look of the packaging, the question surfaced: Will the current adhesives used with the paper label be visible through the proposed poly label?

Having relied on APPLIED Adhesives to provide adhesive products and expertise for years, the baby-food manufacturer engaged the company to explore the potential for the proposed packaging update. The APPLIED Technical Services team focuses on helping customers navigate adhesive-related challenges.

Evaluating New Products without Sacrificing Production Time

Time is quite literally money on a production line. One research study estimates that the industry can rack up losses in the range of $260,000 per hour of unplanned downtime.[1] As such, the baby-food manufacturer was looking for help with pre-qualifying the updates prior to making significant investments of time or materials in switching to the new, clear poly labels.

The adhesives that were being used on the glass jars with the paper labels included a hot-melt pressure-sensitive adhesive (PSA) and a semi-PSA. The APPLIED Technical Service team utilized its in-house adhesive lab to analyze the project from a holistic perspective, considering:

- What equipment is used and at what speeds?
- What are the substrate materials? What challenges do they present? Is the label sized appropriately to allow for enough room for the adhesives?
- How is the bond assembled? How much glue is being used?
- What is the condition of the product prior to labeling (e.g., temperature, moisture, etc.)?
- What conditions will the bond be subject to from production to end use?
- What are the cost objectives?
- What are the manufacturing plant's conditions, processes, and areas of expertise?

At the start, APPLIED had confidence that hot-melt PSAs were the right choice for this type of application (label on a glass food jar) because the residual tack is present at room temperature, offering significant flexibility to overcome potential disruptions in handling. Even though there was a strong initial hypothesis, APPLIED worked to identify the key performance attributes of the ideal adhesive to enable a comprehensive evaluation.

In this case, taking a comprehensive look enabled the team to design the just-right analyses for the baby-food manufacturer's needs—including some that were not initially requested but proved to be beneficial. For example, although the initial question posed in this case was around adhesive visibility, the APPLIED team wanted to ensure that the necessary adhesion properties would carry forward with the poly labels, which have a lower dyne level (surface energy) than paper labels.

Through continued discussion, the baby-food company became optimistic that APPLIED's analysis could result in the ability to consolidate to a single adhesive for the proposed poly labels and the current paper labels. This solution would also offer the baby-food manufacturer the flexibility to run multiple product lines or substrates in the future.

Testing with Real-World Conditions

Quantitative performance can demonstrate not only how a product works, but why. This is best done using the same materials and methods that would be used during production.

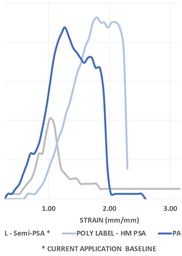
The APPLIED team requested the baby-food manufacturer send samples of the materials used during production, including the glass jars, current paper labels, and proposed clear poly labels. Using the supplied examples of current products to baseline performance and set targets, APPLIED would be able to examine adhesive application to identify potential performance challenges, such as poor machining or pattern location.

Precisely mimicking actual production conditions, the materials were set up in an application-appropriate manner for customized testing unique to the project (e.g., applying adhesive in a method similar to an actual production line capable of speeds up to 1,000 units per minute). The testing procedures included:

- Making samples on release paper of each current adhesive
- Trimming film samples
- Simulating pickup application (applying adhesive to the glass jar, removing release paper, applying label stock over the adhesive film, and heating the jar for adhesive wet-out)
- Simulating lap application (applying adhesive to label stock, removing release paper, applying a second label over the first, and heating the assembly for adhesive wet-out)
- Conditioning samples for 24 hrs before placing in force-testing machine (simulate tensile forces

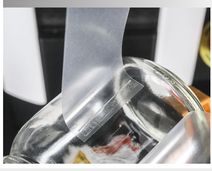
Thorough testing examined:

- Lap bond strength using a modified loop tack test, where two loops of label material are adhered to each other (instead of one loop contacting a metal plate)
- Pickup bond strength using a force tester to grip the glass jar and pull the label at an angle to the bond
- Visibility by applying the adhesive to the poly labels and applying the labels to the glass jar



Lap bond strength was evaluated using a modified loop tack test, where two loops of label material are adhered to each other (instead of one loop contacting a metal plate).

In pickup bond strength testing, a force tester grips the glass jar and pulls the label at an angle to the bond.



Providing a Data-Driven Recommendation

Prior to beginning this evaluation, a thorough review of available technical data sheets indicated that multiple products may have been suitable for the new product label. However, the APPLIED evaluation concluded that one specific PSA was clearly the best option for the application.

The overlap application results confirmed compatibility of the PSA with both paper and poly labels, showing peak stresses of 0.36 MPa and 0.32 MPa, respectively. The pick-up application using the semi-PSA on paper labels showed a bond strength with a peak stress of 0.21 MPa. By switching to the PSA, the baby-food company was able to effectively double the bond strength on the paper labels, with a peak stress of 0.43 MPa. The PSA shows further improved bond strength on poly labels, with a peak stress of 0.46 MPa.

Furthermore, the APPLIED team also uncovered a process improvement to consolidate and use one PSA for all applications, which created additional benefits for the baby-food manufacturer. Although the two adhesives used with the paper labels each have roughly the same cost, switching to one adhesive product decreases inventory requirements. In addition, a single product is one less worry for line operators. It eliminates the need to fill different tanks with separate adhesives, improving line productivity.

For more information, visit www.appliedadhesives.com.

Reference

1. "Minimising Production Downtime in Food and Drink Manufacture," HPS Hygienic Pigging Systems, www.hps-pigging.com/minimising-production-downtime-in-food-and-drink-manufacture.

Figure 1. The overlap test results showed peak stresses of 0.36 MPa for the paper labels and 0.32 MPa for the poly labels.

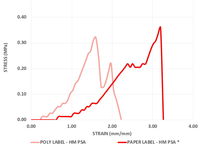
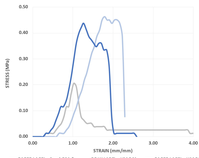


Figure 2. After switching to the PSA, pick-up testing showed that bond strength was effectively doubled on the paper labels, with a peak stress of 0.42 MPa. The PSA showed further improved bond strength on the poly labels, with a peak stress of 0.46 MPa.



SUSTAINABLE PACKAGING: AN OPPORTUNITY TO STAY COMPETITIVE IN A POST-COVID WORLD

A recent survey explores the trend toward sustainable packaging and possible ramifications for decision makers in the packaging sector.

By Steve Molinets, Key Account Manager and FTA Implementation Specialist, tesa tape, inc.

Looking ahead, sustainable packaging represents an important opportunity for the print and paper industry. This comes as consumer packaged goods (CPG) companies increasingly seek to make their products more sustainable, along with the packaging they use.

Sustainable (also known as green) packaging employs materials and manufacturing techniques designed to diminish energy use and reduce the harmful impacts of packaging on the environment, including landfill waste. Simply put, green packaging is defined as product design and use resulting in increased sustainability.

The growth potential is significant. According to the NYU Stern School of Business, for example, between 2015 and 2019, conventionally marketed products had a compounded annual growth rate of just 0.83% compared to 5.86% for sustainability-marketed products.[1] Consumers are making their voices heard.

During approximately that same timeframe, the *Harvard Business Review* reports that categories with the largest share of sustainability-marketed products included toilet and facial tissue, milk, yogurt, coffee, salty snacks, and bottled juices (more than 18%). Meanwhile, laundry care, floor cleaner, and chocolate candy had less than a 5% share.[2]

A World of Opportunity

Globally, the shift is even more dramatic; the worldwide green packaging market is expected to reach $413.8 billion by 2027, growing at a compounded annual rate of 6% from 2020 to 2027.[3] This trend is being driven by a shift away from single-use plastic packaging to paper or compostable materials as consumers focus on the impact of their buying decisions and rely more heavily on online purchases.

What's at stake? The World Bank has estimated that our planet produced 3.5 million tons of solid waste per day in 2010, and that amount is projected to double by 2025.[4] That's why, according to the Consumer Brands Association, many CPG companies have common 2025 sustainability goals, with waste reduction being a top priority.[5]

For example, Nestlé has stated its vision that none of its packaging, including plastics, ends up in landfill, oceans, lakes, or rivers. To achieve this, Nestlé has committed that 100% of its packaging will be recyclable or reusable by 2025. Meanwhile, last year, Walmart issued a set of plastic waste reduction commitments leveraging its private brand program. These new commitments are expected to impact over 30,000 SKUs.

Beyond advances in packaging design and materials, packaging printers can play an important role in helping CPG companies meet their waste reduction sustainability goals. They can also do so by reducing landfill waste from their production processes.

CPG Decision Maker Survey

To better understand this opportunity for our print and paper customers, tesa surveyed CPG decision makers and conducted one-on-one follow-up interviews. Participants ranged from brand managers to packaging designers and sustainability officers.

When it comes to the selection of packaging printers and the setting of sustainability targets by CPG companies, we found that multiple decision makers are involved. In addition, while the procurement or resource manager roles are key, since they are ultimately the final decision makers, meeting corporate sustainability targets is a shared responsibility at many CPG companies.

Multiple decision makers are involved when CPG companies select packaging printers and set sustainability targets.

More importantly, CPG decision makers are open to packaging solutions that can help them meet their 2025 sustainability targets. Four out of five told us that staying ahead of the curve for sustainable packaging will help them remain competitive in the years ahead as consumers and large retailers increasingly demand sustainable products. This provides innovative packaging printers with a clear opportunity to drive business growth through helping CPG companies produce more sustainable packaging—and produce packaging more sustainably.

Choosing a Printer

In our survey, most respondents (88%) indicated using external suppliers for product packaging printing. The process of selecting packaging printers varied among respondents; however, not surprisingly, quality, price, and previous relationships were seen as important factors when deciding which printer to use.

More than half of respondents said their procurement or resources management roles are the final decision makers in the selection of packaging printers. Packaging design, marketing, product and brand management, and sustainability officers also play influential roles.

Establishing Sustainability Targets

We found that various roles are also involved in setting sustainability targets for product packaging. Topping the list includes procurement (or resources management) and packaging design. Not far behind are sustainability, marketing, and product and brand management.

The bottom line is that sustainability is important to CPG packaging decision makers. This includes a focus on recyclability and reducing waste, as well as waste reduction during packaging printing. Further, CPG decision makers are open to looking at packaging solutions to advance their sustainability efforts. For example, over two-thirds of respondents said they are receptive to collaborating with supply chain partners on sustainability scoring topics.

The vast majority of respondents (85%) said innovative solutions that can help packaging printers reduce waste matter to their sustainability efforts. An overwhelming number added that packaging printers can play an important role in partnering with CPG companies to help meet waste reduction sustainability goals.

Adding Downstream Value

Plate-mounting tapes play a critical role in the package printing process. However, the traditional approach to printing flexible packaging is to employ single-use tape, which can result in tons of waste headed to the landfill every year for just a single packaging printer. To enable packaging printers, as well as brand and sustainability leaders at CPG companies, to understand the solid waste generated by single-use tape in the package printing process, tesa is developing a waste diversion calculator.

Once the potential savings are established, printers can see the waste reduction benefits of taking action to make packaging printing more sustainable. Further, printers can then help CPG companies achieve their 2025 sustainability goals through significantly reducing landfill waste from the packaging printing process.

For example, an independent audit shows that by switching from single-use tape to a reusable plate-mounting technology, a packaging printer could potentially save more than 120 tons per plant of solid waste for an eight-color wide-web process. For printers, this can also mean significant cost and efficiency savings on jobs using a common repeat.

Outpace the Competition

Sustainable packaging can help packaging printers successfully compete in a COVID-19 world and beyond. Working with CPG companies to meet the growing market for sustainably packaged goods is a way for packaging printers—and those who support them—to add value and differentiate themselves in an increasingly competitive marketplace.

For more information, contact the author at smolinets@tesatape.com or visit www.tesatape.com.

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DEVELOPING SUSTAINABLE PACKAGING SOLUTIONS

Recycling and recyclability are key factors that sustainable packaging producer EcoEnclose considers when developing ecommerce packaging solutions.

By Susan Sutton, Editor-in-Chief, Integrated Media

Many industries have struggled due to the impact of COVID-19, but ecommerce certainly isn't one of them. eMarketer reports that retail ecommerce sales alone grew 27.6% globally in 2020, to reach nearly $4.3 trillion. Though ecommerce growth in the retail space is expected to decelerate as pandemic restrictions ease and vaccinations climb, it is still projected to see a healthy increase of 14.3% this year.[1]

The massive increase in ecommerce shipments has led to a profusion of packaging materials. As Saloni Doshi, CEO of EcoEnclose, asks, "How many of us have a garage or a room full of boxes that we're trying to figure out how to recycle? As ecommerce grows, people are even more and more cognizant of, 'OK, there's so much packaging, what can I do?'"

Doshi actually took this question to heart back in 2015, when she and her husband purchased EcoEnclose from company founder Erin Kimmet. "We were really excited about the work that she had done to build the beginning of this idea—let's take packaging that's out there and make it more sustainable," Doshi says.

EcoEnclose paper mailers are 100% recycled and recyclable.

What started as a small operation with four or five employees has grown to develop and produce myriad types of sustainable packages, from poly and paper mailers to custom corrugate boxes, the majority of which are 100% recycled and recyclable. I recently spoke with Doshi about the company, its assessment and use of sustainable adhesives, and what she envisions for the future of sustainable packaging.

What products does EcoEnclose offer now?

We have a 100% recycled poly mailer, and 50% of it is post-consumer waste, which is really exciting. We've got a line of various paper mailers, all of which are 100% recycled. We make hundreds upon hundreds of custom boxes every day ... and those are also 100% recycled, 90%-plus post consumer.

We also have a range of post-production custom printing capabilities. For just 500 mailers or more, a company can get their brand on the package. And we have packaging accessories like shipping labels that are 100% recycled, recyclable tape, packaging paper, and void fill.

What we're focused on is asking: What does every different type of company need to package? What packaging do they need to ship their goods, and how can we make those things more sustainable?

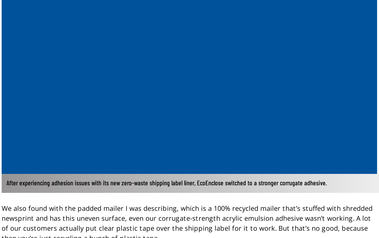
Firm pressure is all that is required to seal these 100% recycled paper mailers.

You mentioned tapes and labels. Can you go into a little bit more detail about the types of adhesives that you use?

When we think about adhesives, it's a combination of two things. The first is adhesive strength, and the reason for that is because recycled paper is really hard to adhere to. We've got all of these boxes that are 100% recycled that have shorter fibers than a virgin box counterpart, and what we were finding is that traditional labels, like a UPS shipping label, wouldn't adhere very well. It was probably made with an all-temp, all-purpose acrylic emulsion adhesive. We also have something called a padded mailer, which is really cushioned, and that uneven surface made those traditional labels a little bit harder to adhere.

The second thing we consider is adhesives on our own unique, sustainable labels. We created a product with a manufacturing partner that is a really unique shipping label because the release liner is 100% recycled and curbside recyclable. It's a patented product and only created with this one manufacturing partner. We call it the zero-waste label, and we were so excited about it. But we found that even in our warehouse, when we were shipping to our customers, the original adhesive we used wasn't strong enough and was peeling off our 100% recycled boxes.

We realized that we can't have a sustainable alternative label out there that's not working because the boxes wouldn't get to where they're going. That's not sustainable at all. We then moved to a higher strength corrugate adhesive, and it's just been working beautifully.



After experiencing adhesion issues with its new zero-waste shipping label liner, EcoEnclose switched to a stronger corrugate adhesive.

We also found with the padded mailer I was describing, which is a 100% recycled mailer that's stuffed with shredded newsprint and has this uneven surface, even our corrugate-strength acrylic emulsion adhesive wasn't working. A lot of our customers actually put clear plastic tape over the shipping label for it to work. But that's no good, because then you're just recycling a bunch of plastic tape.

For that line, we've introduced hot-melt adhesive shipping labels. They're pure polymer adhesive, so in some ways it's not the level of sustainability we would want from the label itself. But, it adheres to that padded mailer and you don't have to tape it up, making the entire package more effective and sustainable.

For us, especially with adhesives and labels, the first thing we want to make sure is the label is going to stick to the recycled paper package and get delivered safely. The least sustainable thing we can do is not get the package there. Then the second is, as much as possible, designing packaging and labels for recyclability with those recycle-compatible adhesives.

What do you see for sustainable packaging in terms of trends for the future?

When I look at the future of packaging, I have two mindsets. One is increased amount of reusability. Right now, a couple of our mailers are inherently reusable. They've got a dual tear strip on them, so somebody can either use the package to ship to somebody else or they can ship their returns back in it. If you can get two or three or four life cycles out of a package, that's incredible. And then it gets recycled.

Another area that I see a lot of growth in is that we need to drastically improve recycling rates and the recycling infrastructure in our country. I'm thinking about my garage that's full of boxes right now. I run a business that has a baler and that gets a pickup for corrugate, and I'm still sitting on all of this.

All of us should be able to get our cardboard and our paper and our plastic back to a recycling infrastructure where they can cost effectively and really efficiently turn that back into new product. We need to, as a country, make investments in the recycling infrastructure so that each material can have its life extended, hopefully five, six, seven, eight, nine times before it goes away.

EcoEnclose's custom printing capabilities give companies the ability to add branding to their sustainable packages.

I also think a lot of ecommerce brands that are focused on sustainability are trying to figure out how to make paper products work for them. We offer a 100% recycled poly mailer, but there is no plastic that's durable enough to make it through a supply chain that is going to then fully biodegrade in the ocean, even if it's made of bioplastic.

And so I think those companies are being really thoughtful: "How can I make sure that it's going to not rip in transit, and it's going to hold itself together, not get torn, and still be presentable at the customer's doorstep?" Paper solutions are more likely to be recycled, and they're not going to contribute to ocean plastic pollution, so let's figure out how to make them work well for ecommerce.

To listen to our full conversation with Saloni Doshi, visit www.adhesivesmag.com/podcasts. Visit www.ecoenclose.com to learn more.

Reference

1. Cramer-Flood, E., "Global Ecommerce Update 2021," January 13, 2021, www.emarketer.com/content/global-ecommerce-update-2021.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LEAN MANUFACTURING: MINIMIZING COSTS WITH MOISTURE AND COAT WEIGHT CONTROL

Converting process efficiency is often affected by variations in coat weight, inefficient moisture control, and thickness and/or temperature issues.

By Sarah Hammond, Marketing Manager, MoistTech Corp.

Producers focus on minimizing waste, reducing costs, increasing product quality, and maximizing plant efficiency. Wasted efforts are certainly a drain on resources, in addition to wasted product, creating the need to evaluate and implement lean manufacturing principles. Identifying the key areas in which the manufacturing process is not operating at its peak efficiency provides the framework for improvement.

Minimizing costs is a top priority for producers, and thoroughly evaluating methods of decreasing waste can reduce wasted efforts, wasted product, and wasted energy. Converting process efficiency is often affected by variations in coat weight, inefficient moisture control, and thickness and/or temperature issues. Moisture and thickness can play a key role in the final product's quality and use.

Measurement and Control

Precise moisture levels in paper, pulp, tissue, corrugated liner, and other converting products are a crucial component to the manufacturing process. Out-of-tolerance moisture levels create wasted product, increased energy usage, downtime, and more. Processing lines can see improved product quality and increased productivity with proper moisture monitoring, creating substantial cost savings. Maintaining the ideal thickness and coat weight in the production line can mean the difference between a quality product or wasted effort and material.

Many basic properties of paper are greatly affected by moisture content. Paper dimensions, flatness, conductivity, strength, and fold are among the more significant properties influenced by moisture content. These properties can be critical to the proper performance of paper; providing effective control of paper moisture levels and moisture uniformity is essential for efficient printing and converting operations.

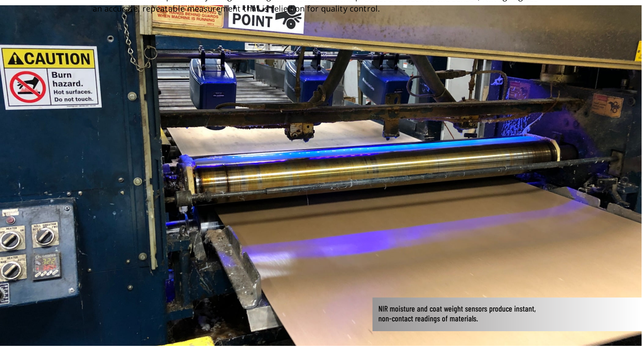
Moisture and coating technology provides a proactive path to avoid quality control issues. Installing sensors throughout the process ensures consistent and accurate measurement of 100% of the product with proactive, immediate adjustments to the line. Real-time results are recorded and displayed every second to operating personnel via PLC, providing full control of the line. In addition, some sensors can ensure that feedback loops have predictable and repeatable results, even at high operating speeds.*

With implemented moisture monitoring, processing, and manufacturing, plants can see large savings in little time. Producers are missing a large opportunity for increased efficiencies if there is no current method of moisture measurement in the production process.

Near Infrared Sensor Technology

Various components are vital in the converting process and should be evaluated for optimal performance. Near-infrared (NIR) technology* provides an efficient, non-contact measurement of multiple constituents, immediately improving product quality and plant efficiency. These sensors provide continuous, reliable readings with a one-time calibration, maintenance-free, no-drift optical design, allowing for immediate process adjustments based on real-time data.

Multiple detection methods are available for the converting process, but not all technology is created equal. NIR technology differs from traditional methods, as it does not have to be in contact with the product, is non-destructive, and is insensitive to most material variations. NIR provides fast analysis of the chemical and physical information in the product by using an NIR light. Reflected into the product and back to the sensor, NIR light gives an accurate, repeatable measurement, making it ideal for quality control.



NIR moisture and coat weight sensors produce instant, non-contact readings of materials.

Designed for effectiveness, the NIR moisture and coat weight sensor produces instant, non-contact readings of materials anywhere in the production process, reducing startup and down times. Final product quality is critical; by measuring moisture, coat weight, or thickness, the producer can ensure the quality of the product and sell it for maximum profit. NIR is useful in multiple converting applications, including but not limited to:

- Pressure-sensitive adhesives
- Hot melts
- Resins
- Films
- Hydrocarbon and water-based coatings
- Paper and pulp
- Corrugated materials

Lean Operations

Maximizing automation and increasing reliability by reducing costs are major aspects for operation that can be easily achieved through proper moisture and coat weight monitoring. Moisture ranges outside of tolerance can unravel important facets of the production process. Each phase of manufacturing runs more efficiently with accurate moisture and coat weight measurements, providing increased profit margins.

If moisture is not properly regulated during the production process, the end quality becomes inferior and product waste occurs. Identifying and using the best methods can lessen common problems such as curl, warping, breakage, collapse, flute exposure, and reduced edge control and lay flat.

Uneven moisture stratification can cause shrinkage or expansion of cellulose fibers. Curled stock is an issue for printing and packaging, and coatings can also get thinner or thicker at the edges. Different moisture levels on the top and bottom side of corrugated board causes warp issues. Therefore, strict control of moisture helps enable operators to produce high-quality boards and boxes.

With the ability for installation in the most extreme production locations, including along webs, winders/unwinders, dryer entrances/exits, pipelines, pneumatic conveying, or in fluid-bed dryers, plant operators can take full advantage of implementing lean operating principles on measurement and control. Adjustments are made on the fly, producing instant measurements to improve performance, reliability, and consistency. Catching any out-of-tolerance readings as soon as possible helps avoid costly downtime and dramatically decreases the amount of wasted product.

Measurement and control sensors can be installed in extreme production locations, including along webs.

Production efficiency improvements due to accurate real-time measurements provide the plant with energy savings and potential increased productivity with lower material losses. Delivering the highest quality product by utilizing NIR moisture detection systems ensures accuracy and repeatability. The sensors are insensitive to material variations such as particle size and material height/color, providing continuous reliable readings with zero maintenance, one-time calibration, non-contact, and a non-drift optical design.

For more information, call (941) 727-1800 or visit www.moisttech.com.

*IR3000 NIR sensors from MoistTech

MODERNIZING ASSEMBLY LINES WITH UV LED CURING

Adhesive bonding, sealing, and coating processes in factory assembly lines are rapidly upgrading to UV LED curing technology.

By Jake Chaney, Regional Sales Manager, and Stacy Hoge, Marketing Communications Manager, Phoseon Technology

Ultraviolet (UV) light-emitting diode (LED) curing technology offers significant advantages compared to traditional mercury UV curing. As a result, adhesive bonding, sealing, and coating processes in factory assembly lines are rapidly upgrading to UV LED curing technology.

Traditional mercury UV bulbs degrade over time, making them unstable and in need of replacement every 1,000-1,500 hours. In contrast, UV LED provides stable UV output consistently over many years, leading to better process control and stability for manufacturing operations.

UV LED Advantages

As mentioned, UV LED curing offers multiple advantages in comparison to mercury UV curing. Benefits can be found in terms of: depth of cure, full cure, low heat, replacement components, and reliability.

Depth of Cure

With long wavelengths in the UVA range, UV LEDs offer excellent depth of cure. Because of these long wavelengths, UV LEDs are significantly more effective at curing adhesives than mercury lamps. The higher irradiance of UV LEDs at 365 nm penetrates deep into the chemistry, making the technology ideally suited for adhesive and sealant applications. Adhesive chemistries include silicones, acrylate/urethanes, cyanoacrylates, anaerobics, pressure-sensitive adhesives, film adhesives, and epoxies.

Full Cure

The stable and long-lived output of the LED lamp ensures full cure all the time. UV LED lamps have been reported to exceed 60,000 hours while still producing the specified power.

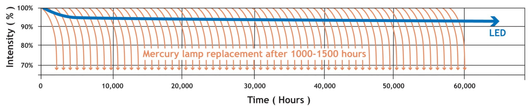
Low Heat

UV LEDs do not generate any infrared output that is translated into heat. This is extremely important on manufacturing lines where the introduction of heat results in changes in the chemical properties of the adhesive or deformation of the substrate. In some cases, heat can lead to material warping, lack of adhesion, and eventually scrap. UV LEDs are a "cool" light source; the only heat generated is a byproduct of the absorption of UV energy.

No Replaceable Components

As previously mentioned, conventional mercury bulbs have a short lifetime, while LED curing lamps can extend beyond 60,000 hours if maintained properly. Upgrading to UV LED eliminates replacement costs associated with traditional UV technology.

Figure 1. UV LED lamps have been reported to exceed 60,000 hours while still producing the specified power.



Reliability

LED technology is a solid-state technology that does not degrade, even when continuously flashed on and off. The long lifetime, instant on/off control, and consistent UV output reduces process variability and advances process control. With thousands of commercial installations across the world, LED curing technology has been proven to be extremely reliable.

Environmentally Sustainable Technology

LED is the only sustainable choice for UV curing. LED technology does not contain toxic mercury like traditional UV curing technology. The regulation of mercury in manufacturing processes is growing globally.

For example, the Minamata Convention on Mercury is a global treaty to protect human health and the environment from the adverse effects of mercury. Highlights of the convention include a ban on new mercury mines, the phase-out of existing mines, the phase-out and phase-down of mercury use in several products and processes, control measures on emissions to air and on releases to land and water, and the regulation of the informal sector of artisanal and small-scale gold mining. The convention also addresses interim storage of mercury and its disposal once it becomes waste, sites contaminated by mercury, and health issues.

Traditional UV-curing mercury bulbs also produce harmful gases and ozone that must be evacuated from the work area (and often completely out of the facility). The required exhaust systems are bulky, loud, and require a significant amount of energy. UV LED does not generate greenhouse gases or ozone, and it reduces CO_2 emissions by more than 50% compared to mercury lamps.

By upgrading to UV LED, users have experienced energy savings of up to 85%.

As a result of the need for numerous bulb replacements, conventional mercury lamps generate a significant amount of waste over time. The long lifetime of properly maintained LED curing lamps results in less waste, as well as the elimination of the associated replacement costs.

Traditional mercury UV lamps require a significant amount of electricity to operate. By upgrading to UV LED, users have experienced energy savings of up to 85%. A key contributing factor to this savings is the instant on/off nature of the technology. LED lamps are only on when they are curing; in standby mode, they are completely off.

Applications

UV adhesive curing application segments include electronic assembly, automotive, medical, ammunitions, pressure-sensitive films, general assembly, and other manufacturing processes. UV LED curing technology is ideally suited for electronic assembly applications. The combination of high-energy UV LED sources with the appropriate adhesive enables increased productivity while also providing the ability to cure heat-sensitive materials. Today, many electronics manufacturers use UV LED curing in the production of products such as touchscreens, mobile phones, micro-speakers, and hard disk drives.

General assembly, industrial-grade bonding processes require products that can work in tough, sometimes harsh manufacturing environments.

In automotive coating applications, UV LED provides near-instant curing of functional and decorative coatings. The lightweight materials used in today's automobiles benefit from the low temperature of UV LED technology. The automotive industry uses UV LED curing solutions for forward lighting, tail lenses, interior and exterior trim components, and body panels.

Adhesives used in medical applications, such as syringes, catheters, IV delivery systems, endoscopes, and hearing aids, often benefit from UV curing technology. Properties such as better uniformity, low heat, instant on/off, and long lifetime are ideal for this highly regulated industry.

UV LED curing solutions are used in ammunition production for waterproofing, adhesive bonding, sealing, and coating. The UV LED curing of external ammunition sealants can make bullet pull strength more consistent, thereby improving performance and accuracy. Example ammunitions-related applications include external ammunition sealing (i.e., waterproofing); igniter, fuse, and detonator UV sealing; specialty UV coatings and primers; blank ammunition sealing; shot shell crimp sealing; and tip color coding.

General assembly, industrial-grade bonding processes require products that can work in tough, sometimes harsh manufacturing environments. Industrial UV LED curing applications include EV batteries, solar panels, wood/plastic coatings, thin films, bottle processing, aviation, automobiles, and many others.

Worldwide Solutions

UV LED solutions are being used worldwide for curing adhesives, sealants, and coatings. Recognized advantages include lower operating costs, enhanced system capabilities, and environmental benefits that contribute to a safer and more productive workplace.

For additional information, visit www.phoseon.com.

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ADVANCING SILICONE-BASED MEDICAL ADHESIVES

A new adhesive for wearable medical devices enhances patient comfort while providing engineers confidence about wear duration.

Acrylate and silicone have dominated the medical adhesives market for years. However, the adhesives currently available often require device engineers to choose between strength and wear duration, or comfort and pliability. To address these issues, 3M developed what the company is calling the next generation of its silicone adhesives, 3M™ Hi-Tack silicone adhesive tapes.

3M reports that the new 2480 3M Single Coated Medical Nonwoven Tape with Hi-Tack Silicone Adhesive on Liner provides increased sheer performance, higher tack, stronger adhesion, and longer wear duration. The adhesive is repositionable, flexible, and conformable to work well with various medical devices, including continuous glucose monitoring systems, wearable monitors, and sleep and incontinence devices. It is strongly bonded to the backing to minimize residue on both skin and production equipment, and it is compatible with ethylene oxide (EtO) sterilization.

ASI Editor Susan Sutton recently spoke with John Dugas, global portfolio manager for 3M Medical Materials and Technologies, about the new adhesive, as well as the various factors involved in product development for adhesives used in medical applications.

What are some of the special considerations that adhesives producers need to take into account when focusing on medical end uses?

It's really complex. You have to consider regulations. You need to consider if you can even manufacture the device and use it appropriately when you're making it. But by far, the biggest consideration is patient safety when we're dealing with adhesives in the medical space. And there's a couple of factors within patient safety that make it critical.

First of all is the device itself. You have to work with the device so it's safe. But second, and I will say more important, is making sure you've got the right design and the right adhesive on there to minimize any unintended effects. If you go in for a cardiac monitor, you don't want to come out of the hospital with irritated skin. Poor device and adhesive compatibility can turn people away from treatments and keep them from getting the appropriate regimens.

The adhesive is repositionable, flexible, and conformable to work well with various medical devices, including continuous glucose monitoring systems, wearable monitors, and sleep and incontinence devices. (Image courtesy of 3M.)

That's why we've been working a lot on this different class of adhesives that are gentler, which helps reduce the aspect of skin trauma and discomfort from the patient equation so that they can really focus on the treatment themselves and the devices themselves, not the ancillary parts like the adhesive holding it in place.

What were your main goals when you were in development for this new product?

I'll go back, first of all, to patient safety—to come out with the gentlest adhesive to minimize skin trauma and discomfort as we could. The other aspect is we're seeing a lot of trends in the medical marketplace, especially in the wearable or monitoring market. I'll give you a really good example. Healthcare data is one of the fastest growing areas in healthcare. And what that data does is it helps enable better patient treatment paths.

Think about diabetes, which is one of the fastest growing chronic diseases on the planet. We used to manage diabetes by pricking your finger two or three times a day to get your blood glucose level. We had three points of data, and you'd adjust your blood glucose three times a day. So you could spike really high. You could go really low. Now, the new glucose monitors are held in place on the skin, and they're continuously monitoring them so they can make little adjustments instead of big swings. Think about body temperature for COVID patients. You want to continuously monitor temperature, so you've got sensors that you wear 24 hours a day to monitor how it goes up and how it goes down. Blood oxygen is another thing. The role of healthcare data and monitoring is just growing really fast.

As we're looking at adhesive challenges out there, we have to come up with adhesives that plan for that trend and additionally support capturing that information. Devices are getting more complex, they're getting heavier. They're going on different parts of the body. Whether you're monitoring brainwaves, glucose, heart conditions—they're going all over the body. We really focused on that gentle adhesion, but at the same time finding the right adhesive that increases wear-time and can hold on those heavier and more complex devices for the time they want.

We don't always have the ability to change the device every hour. Medical professionals might want to put something on that's a complex device with the appropriate battery to monitor that patient without having to go and check their temp or move it around or replace it every hour. This is why we focused on adhesion and wear time, which is where high-tech silicones come in. They've got the gentleness of silicones, but they've got the holding power and wear duration that you expect for more complex monitoring devices.

What are some of the other factors that need to be taken into consideration when developing these types of wearable medical devices?

A really good example is repositionability. When you're talking about the increase in the monitoring market, especially in neurological applications or heart monitors, you may have to find a specific spot on your body to be able to get the right signal. So being able to reposition a device may be really critical for your product.

I think the second thing that we're really looking at and driving for is the adhesion level, because devices are being worn for longer periods of time. To satisfy that longer wear time, you have to look at different types of adhesion; adhesion is just not one concept. You can have tack from an adhesion standpoint. How sticky is it? Can I put it on and it stays in place so I can get that original signal and move it around? We also spent a lot of time on shear. If you're walking around all day and you've got a device on your body, you have to make sure it doesn't slide down your body, which is the shear force in your adhesive.

I think the last thing I'd like to mention that we forget about as you're talking to adhesive and device manufacturers is manufacturability. Sometimes we don't consider the manufacturability of the product. When you're looking at new areas or new materials, you forget that someone's going to have to manufacture it. Consider sensors as an example. Some companies are already manufacturing millions and billions of sensors, and you can't be cutting those out individually or running a slow process.

We did spend a lot of time with these new adhesives, focusing on making sure, for example, that they're really thin so they conform to your manufacturing process, or don't apply too much adhesive. Also, we made sure it bonds well to the liner because you don't want to run for 30 minutes and then have to shut down, clean up, and then run again. We have to make it easy for companies to manufacture, because if we can't get the product out the door, you can't help the patient out.

You might have the best product in the world, but if they can't actually apply the product, then it's not doing anybody any good, right?

Absolutely. There's so many things going on in healthcare with COVID, and it's just changed the industry. With these monitoring devices, we've seen an explosion in the number of devices that people are rolling out quickly to make it work. For example, with protective equipment, adhesives can help hold some devices in place. There's a lot of opportunity and growth out there just based on the changing market now. And we're all trying to help out with so many unique things going on.

Listen to our full conversation with 3M's John Dugas at www.adhesivesmag.com/podcasts. To learn more, visit www.3m.com/scienceofsilicone.

Image Source via Getty Images

BETTER BONDING: SIMPLIFYING PRESSURE-SENSITIVE ADHESIVE SELECTION

Taking a systematic approach and using selection tools available from adhesive manufacturers can streamline the pressure-sensitive adhesive selection process and help ensure strong bonding in each application.

By Kyle Witham, Product Development Engineer, Avery Dennison Performance Tapes

The ideal pressure-sensitive adhesive (PSA) delivers exactly the right amount of bonding at the lowest cost. Choosing the right adhesive hasn't always been easy, however. We have all heard stories about adhesives failing prematurely, as well as how costly those failures can be to product manufacturers.

There is much to consider when matching an adhesive to a particular substrate and application. Yet, the process does not have to be complicated. Taking a systematic approach and using selection tools available from adhesive manufacturers can streamline the selection process and help ensure strong bonding in each application.

Core Concepts

A couple of concepts are helpful to understand before getting started. The first is rheology, or the study of the deformation and flow of matter. In regard to adhesives, rheology is used to match the specific qualities of an adhesive to the characteristics of the substrate. You do not have to understand the science of rheology, just know that while all adhesives are elastic and viscous, some are softer and more fluid and others are more firm. Adhesive manufacturers use these differences to match an adhesive to the characteristics of a substrate.

The other key concept is surface energy, which represents the receptivity of a material to an adhesive. High-surface-energy materials are those that are easy to bond to, such as most bare metals. Low-surface-energy materials are less receptive to bonding; examples include powder-coated materials and many plastics.

Different methods can measure the specific surface energy of a material, but this typically is not necessary. The surface energy of common substrates is known, and adhesives can be accurately selected based on a classification of a substrate's surface energy as high, medium, low, or very low. While lower surface energies create more of a bonding challenge, strong bonds can be achieved even on extremely low-surface-energy materials if the right adhesive is used.

Figure 1. Surface energy selection guide.

Adhesive Types	HIGH: Aluminum	HIGH: Stainless Steel	HIGH: Copper	HIGH: Glass	HIGH: Polyurethane (PUR)	HIGH: Nylon	HIGH: Polyester (PET)	HIGH: Polyurethane (PU) Foam	MEDIUM: ABS	MEDIUM: Polycarbonate (PC)	MEDIUM: Vinyl (PVC)	MEDIUM: Acrylic	MEDIUM: Polystyrene	LOW: EVA	LOW: Powder-Coated Panels (PC [GM05])	LOW: Polypropylene (PP)	LOW: PVC (Textile)	LOW: UHMW-Polyethylene (PE1000)	X-LOW: PTFE (Teflon®)	X-LOW: Silicone
General Purpose Rubber	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	○	○	○	○	◑
High Shear General Purpose Rubber	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	○	○	○	○	○
Low VOC Acrylic	●	●	●	●	●	●	●	●	●	●	●	●	●	◑	○	○	○	○	○	○
High Performance Low VOC Acrylic	●	●	●	●	●	●	●	●	●	●	●	●	●	◑	○	○	○	○	○	○
General Purpose Acrylic	●	●	●	●	●	●	●	●	●	●	●	●	●	◑	○	○	○	○	○	○
Pure Acrylic	●	●	●	●	●	●	●	●	●	●	●	●	●	○	○	○	○	○	○	○
LSE Modified Acrylic	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	○	○	○	○	○
High Shear Acrylic	●	●	●	●	●	●	●	●	●	●	●	●	●	○	○	○	○	○	○	○
High Performance Acrylic (HPA)	●	●	●	●	●	●	●	●	◑	○	○	○	○	○	○	○	○	○	○	○
Silicone (FT 9302 SF)	●	●	●	●	●	●	●	●	◑	○	○	○	○	◑	◑	◑	◑	◑	◑	◑

○ Low ◑ Medium ● High

What We Are Laminating To

The first step in the process is knowing what we are laminating to. For example, if laminating to a sponge rubber foam, most PSAs will not bond; a silicone PSA would be recommended for this application.

It is also important to note that lamination at room temperature may work well when bonding to closed-cell foams or skinned foams. However, open-cell foams may require heat to allow the adhesive to flow into the surface to achieve a stronger bond.

Know Your Substrate

Next, the adhesive has to be matched to the substrate; this is largely determined by the substrate's surface energy. In general, the higher the surface energy, the broader the range of adhesives that can be selected. In recent years, we have seen increased use of lower surface energy materials such as powder-coated aluminum, TPO/TPE plastics, and EDPM blended polypropylene. These materials generally require softer adhesives with more flow, such as modified acrylics and general-purpose rubber.

Beyond surface energy, the texture of the substrate can also affect adhesive selection. With a textured surface, there is a risk of an incomplete bond if an adhesive with the right flow isn't selected. Textured materials generally require softer, more aggressive adhesives. The tackier the adhesive, the more it will flow and fill the gaps in foams and heavily textured fibrous materials.

To further simplify the process of matching adhesives to substrates, adhesive manufacturers are now supplementing their selection tools with bonding studies conducted in partnership with the manufacturers of common substrates. These studies not only identify appropriate adhesives but also classify the bonding strength of these adhesives with the material.

A final note on bonding to substrates: contaminants, often invisible to the human eye, can reduce the ability of an adhesive to bond. When contaminants exist, it may be necessary to clean the surface by washing or flame treating prior to applying the adhesive.

Know Your Application

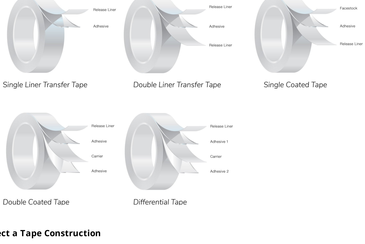
At this point, it is time to consider the environmental factors the adhesive will be exposed to. The most important of these is usually temperature, which can affect whether an adhesive succeeds or fails. A good rule of thumb for temperature resistance is that rubber-based adhesives work for temperatures below 150°F, while most acrylic-based adhesives have a wider temperature range (some can resist temperatures up to 400°F).

Other environmental conditions—including humidity; indoor/outdoor use; exposure to solvents, chemicals, or fuels; and direct or indirect UV exposure—all come into play as well. In general, acrylic-based adhesives have much better resistance to these types of conditions than rubber-based adhesives.

Let's consider a couple of examples to illustrate how application issues can impact selection. An industrial OEM required a die-cut piece of polyimide film to be bonded to aluminum for an electrical insulation application. The assembly would be exposed to temperatures up to 400°F, as well as splashes of coolant. A number of acrylics are capable of creating a strong bond with this substrate and laminate, but, as mentioned previously, most acrylics are rated to 350°F. High-performance acrylics, however, are rated to 400°F, and this was the right adhesive for this application.

In another case, an automotive supplier needed to bond a flexible heat shield constructed of foil and nonwoven PET to a HDPE gas tank. The adhesive would be exposed to temperatures of 325°F, humidity, and potentially small splashes of transmission fluid and gasoline. In addition, the supplier wanted a high-tack adhesive so the parts could be applied quickly. Again, multiple acrylics could work with this substrate, but an LSE-modified acrylic was best suited to handle these application considerations.

Figure 2. Five options for tape construction and liner combination.



Select a Tape Construction

The final step in the process is choosing the tape construction and liner combination. Here, there are essentially five options.

Single-Liner Transfer

Transfer tapes are intended for lamination to flexible rolled or sheeted materials. The liner is removed by the end user upon application to the substrate. Single-liner tapes use an unsupported layer of adhesive with a single liner that is release coated on both sides.

Double-Liner Transfer

In a double-liner transfer tape, one liner is the process liner. This liner is removed prior to lamination. The second, functional liner remains in place during lamination.

Single-Coated Tape

A single-coated tape comes pre-laminated with a facestock, eliminating half the workout for converters. It can be wound with either the liner or facestock facing out.

Double-Coated Tape

This construction features two layers of the same adhesive that are supported by a single liner that is release coated on one side.

Double-Coated Differential

This construction features two layers of the same adhesive supported by a carrier, with either a single liner that is release coated on both sides, or a double liner. Differentials are the same as double-coated tapes, except that they use two different PSAs. This can be useful when bonding two dissimilar substrates together.

Using Available Resources

While there is a lot to consider when selecting a PSA, adhesive manufacturers have made the process easier to navigate with selection tools that converters can use to quickly identify the right adhesive for each application. These tools streamline adhesive selection, but it is still important to select an adhesive early in the design process to ensure the laminate, substrate, adhesive, and tape all work together to deliver the best results for each application.

For more information, contact the author at kyle.witham@averydennison.com or visit www.tapes.averydennison.com.

HOW DOES MINERAL SELECTION IMPACT WATER-BASED ADHESIVES?

The selection and control of the physical properties of minerals are critical in improving an adhesive's performance.

By Shamila Grigorieff, Senior Scientist, Erik van Dijnen, New Business & Technical Manager, and Jane Trewolla, Senior Scientist, Imerys Performance Minerals

Water-based adhesives for paper lamination are typically formulated with different types of binders, including: natural polymers (eg., dextrins and starches), inorganic "polymers" (e.g., sodium silicates), and oil derivative-based polymers (e.g., polyvinyl alcohol and polyvinyl acetate). These adhesives may be formulated as "ready-to-mix" dry powder blends or "ready-to-use" wet blends. Both blend types require the addition of water to achieve the correct viscosity prior to application.

One of the major advantages of the ready-to-mix adhesive types is the absence of organic solvents, which leads to low levels of volatile organic compounds (VOCs) and the reduction of fire hazards during compounding. Another feature of these adhesive types is their controlled water solubility, allowing easy equipment cleaning. It is not surprising that these materials have found wide use in bonding porous paper substrates.

In dextrin paper adhesives, the mineral component can represent over 50 wt% of a commercial formulation. The choice of mineral will therefore have an impact on the ultimate performance of the adhesive in terms of its stability, rheology, and adhesion properties.

Mineral Types

A variety of mineral types can be used in adhesives for applications including wood bonding, packaging, and textile bonding. Ground calcium carbonates (GCCs, $CaCO_3$) are often chosen to modify rheological and adhesion properties to address the correct cost/performance ratio applicable for the relevant application. Maximizing the inorganic content and minimizing the organic binder and the water content is a common trend in such compounds.

Medium-fineness GCCs with average particle sizes of more than 3 microns are commonly used as extenders. Fine GCC grades with average particle sizes of between 0.2-3 microns contribute to the structure and thixotropy.

Other types of minerals can also be considered for this application, including wollastonites ($CaSiO_3$), which are acicular-shaped calcium silicates. The potential benefit of wollastonite is its reinforcing acicular shape and low oil absorption figure, comparable with GCC.[1]

Experimental Details

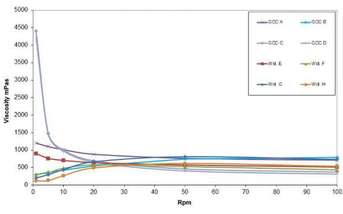
The evaluation of GCCs and wollastonites has been undertaken in a water-based adhesive dry-blend formulation, as described in Table 1. All adhesive mixes were carried out in a Heidolph mixer; 55 parts of water were stirred at 4,000 rpm with a Cowles blade (3-cm diameter), and 100 parts of dry-blend mix was added under stirring. Once the adhesives had been mixed for the required time, they were cooled to 23°C.

The viscosity of the adhesives was measured using a Brookfield viscometer (20 rpm at 23°C). Additional water was then added in increments until the viscosity was between 500 and 800 mPa.s. Brookfield viscosity measurements were made after each addition of water. Solids contents were measured after the final water addition. The rheological properties of the mixes were also measured after 1 week at 23°C, using a Kinexus Pro rheometer with an upward shear rate ramp and a downward ramp (CP 4/40 mobile).

Adhesion properties were evaluated with a peel test. Adhesives were heated to 80°C and applied on a piece of unbleached paper with a 60 µ bar in order to reach ~ 80 g/m^2 coating. Another paper of the same size was placed on top of the glued paper, and then a 3-kg weight was placed on the two pieces of paper for 10 seconds. The weight was removed, and the papers peeled apart after 5 seconds. A rating was given for each mix, from 1 to 5, with 1 being the worst adhesion (100% adhesive failure) and 5 being the best (100% cohesive failure).

Figures 1-6 are included in the carousel below. (Use the left and right arrows to navigate through the figures.)

Figure 1. Viscosity profiles of the adhesives after 1 day of storage at 23°C.



Results and Discussion

The mineral components of the formulation presented in Table 2 were varied to incorporate combinations of fine- and medium-sized GCC (d50 between 1 and 4 µm) and wollastonite. Table 3 gives details of the normalized solids for a Brookfield viscosity of 600 mPa.s. It shows that coarser grades allowed a higher filler loading.

Brookfield viscosity profiles of the formulations incorporating the different minerals are shown in Figure 1. Adhesives produced with GCC C and GCC D exhibited the highest viscosities. The adhesives produced with wollastonites displayed either a constant viscosity or a shear-thickening effect until a certain shear rate.

Rheological profiles of the formulations incorporating the different minerals are shown in Figures 2 and 3. The viscosities obtained with adhesives containing calcium carbonate were higher than the ones containing wollastonite, as seen previously. For three of the adhesives containing GCC, the viscosity of the adhesive tends to increase as the shear rate decreases.

For three of the adhesives containing wollastonite, the viscosity tends to increase until a shear rate of 10 s^{-1} is reached, and then it decreases. This is also valid with the shear rate decreasing. This specific rheological profile is likely to be linked to its needle structure.

Finally, the peel test results obtained on the different mixes are presented in Table 4. Depending on the mineral used and its granulometry, differences could be observed on the peel ratings.

Figures 4-6 present the correlations obtained between the minerals properties and the peel ratings. It can be concluded from these results that the finer the product (i.e., low d50, high percentage above 2 µm, high surface area), the better the adhesion results, whatever the chemistry of the mineral used. Then, at a similar D50 of 4 µm, the wollastonite G gave better adhesion than GCC A.

Conclusions and Recommendations

In water-based adhesives, the use of medium-sized GCCs allowed the highest filler loading, while using finer GCCs led to higher viscosities and rheological profiles with improved shear-thinning effect. These finer grades also enabled better adhesion performance.

In water-based adhesives, the use of wollastonites gave linear Brookfield viscosities and a specific rheological profile under increasing and decreasing shear rates, which is morphology related. The finest grades also enabled good adhesion performance.

In dextrin adhesives for tube winding in particular, GCC C, GCC D, or 50/50 blends are recommended to achieve an optimum performance on adhesion and solids content on test liner and kraft liner paper substrates. GCC A and GCC B, which are coarser, increase the solid content but reduce adhesion and might create premature particle sedimentation.

Wollastonite G and H, due to their acicular shape and particle size, are the most interesting wollastonites to reinforce in paper–adhesive multilayer composite. Reinforcement is potentially achieved by substituting part or the total amount of GCC by wollastonite G or H. Further work is being carried out to characterize a broader range of industrial minerals in other adhesive types.

For more information, visit www.imerys-performance-minerals.com.

References

1. S. Kwon, T. Nishiwaki, H. Choi, H. Mihashi, "Effect of Wollastonite Microfiber on Ultra-High-Performance Fiber-Reinforced Cement-Based Composites Based on Application of Multi-Scale Fiber-Reinforcement System, *Journal of Advanced Concrete Technology*, **June 2015, 13(7):2015, www.jstage.jst.go.jp/article/jact/13/7/13_332/_article.**

Opening image courtesy of foaggo via iStock / Getty Images Plus.

WHAT'S NEW

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H.B. FULLER

Adhesive for Natural-Based Disposable Hygiene Products

H.B. Fuller has launched Full-Care™ 5885, an ECO PASSPORT-certified cotton bonding hygiene construction adhesive solution, to meet industry's growing demand for natural-based hygiene articles. The company reports that the new adhesive addresses increasing demand for more natural-based products.

Cotton and viscose swell when wet, making them more challenging to bond. In response, H.B Fuller developed Full-Care 5885, a high wet-strength adhesive that allows manufacturers to switch to natural substrates like 100% cotton and viscose without having to significantly increase coat weight.

www.hbfuller.com

WACKER CHEMIE AG

Bio-Based Silicone Sealant

With its ELASTOSIL® eco brand now launched in Europe, Wacker is offering products manufactured using bio-based methanol to silicone sealant suppliers. The new brand is based on the REDcert2 standard, which confirms the traceability of renewable raw materials across WACKER's entire production process.

ELASTOSIL eco is WACKER's first approach to encompass and compensate all fossil-based raw materials and additives in the product formulation by using bio-based methanol. To qualify, the purchased bio-methanol has to be obtained from certified sustainable sources. Raw material volumes needed for manufacturing undergo regular audits as part of an annual recertification process.

www.wacker.com/new-elastosil-eco

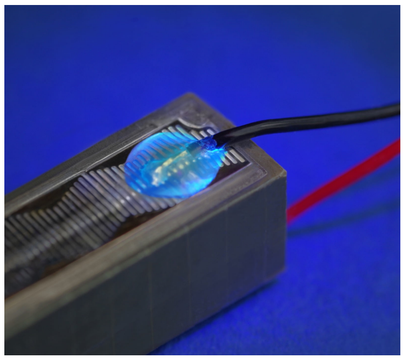
PANACOL

Acrylic Potting Compound for Piezoceramics

Panacol has expanded its portfolio of dual-curing acrylic adhesives with the introduction of Vitralit® UD 8052 F, which was developed for piezo actuators and sensors. According to the company, the new adhesive possesses a particularly high tear resistance for bonding ceramics and plastics.

Vitralit UD 8052 F is a low-viscosity, one-component UV-curable adhesive. It is jettable, transparent, and fluoresces under UV light. Customized versions with different colors are available to facilitate improved process control. Its jet dispense capability makes high units-per-hour values achievable, making Vitralit UD 8052 F an ideal choice for consumer electronics applications.

www.panacol.com



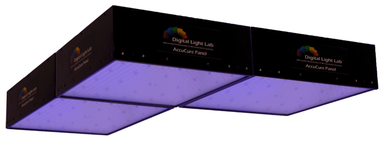
DIGITAL LIGHT LAB

LED Curing Panel

Digital Light Lab has introduced its AccuCure scalable LED curing panel. The new 12 x 12-in. LED panel can be tiled and joined together to fit the desired width and length of any production line or curing tunnel.

The company reports that near-seamless edges produce high uniformity at any distance, and built-in forced-air cooling ensures a longer LED lifespan. In addition, easy integration involves simple plug in and turn on functionality. This AccuCure panel is available in several different wavelengths, including 285, 365, 400, 420, 435, and 445 nm, among others. Custom sizes are also available.

www.digitallightlab.com



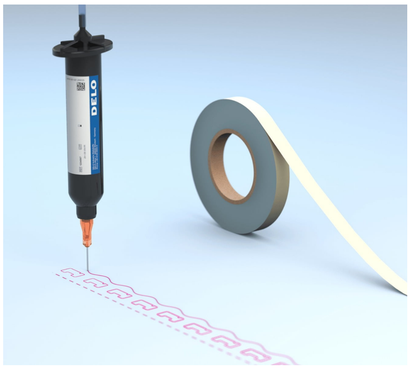
DELO

Liquid Pressure-Sensitive Adhesives

DELO has developed two liquid pressure-sensitive adhesives (PSAs) that reportedly have similar properties to double-sided adhesive tapes. According to the company, DELO PHOTOBOND PS4130 and DELO KATIOBOND PS6372 can be dispensed easily and join components accurately with pressure. Components can then be handled immediately in a fully automated process.

DELO reports that its liquid PSAs offer an advantage over tapes because they are dispensed in liquid form directly onto the component and then irradiated by UV light. Since the adhesives reach their initial strength immediately after the second component is pressed on, the bonded assembly can be processed directly and without any fixing devices.

www.delo-adhesives.com/us



ASK DR. DAVE

PACKAGING MOISTURE-SENSITIVE SEALANTS

Can you recommend suitable materials for packaging a sealant that is sensitive to atmospheric moisture? Additionally, we can do accelerated humidity testing of filled packages, but how do we correlate these with shelf life?

You can obviously package your moisture-sensitive sealant in glass or metal cans or tubes, which will totally prevent moisture ingress. Aluminum tubes are widely used for this type of product, as long as you have good crimps.

You can also use plastic containers. If you can handle a rigid cartridge container, then heavy-walled polyethylene containers will give suitable shelf lives for most products. If a thinner walled flexible container is better, it may be necessary to coat your plastic with a material with very low moisture vapor transmission rates, such as polyvinylidene chloride.

An alternative is to use multilayer film or sheet materials to construct your package. These types of films are widely used in the food packaging industry.

Many companies have a history of shelf life testing, but one of the simplest ways to estimate the shelf life of your product is to calculate the vapor pressure of water under both your test conditions and the ambient conditions where it will be stored. For example, if you find that your product is still within specifications after 1 week at 85°C and 100% relative humidity (RH), the vapor pressure of water under these conditions is 433.6 mm (from tables in any good materials handbook).

You can calculate the vapor pressure of water under ambient conditions by first checking weather tables for any particular location in the world. For example, if average conditions at a location are 20°C and 50% relative humidity, the average vapor pressure of water under these conditions is 17.535 mm (from tables) x 0.5 (50% RH) = 8.76. If you divide the vapor pressure under your test conditions by the value at the location, this should allow you to estimate the shelf life. In our example here:

Shelf life = 433.6/8.76 = 49.5 weeks

Dr. Dave is a former vice president and director of Loctite Corp. (now Henkel) and has spent many years in troubleshooting adhesive and sealant problems in the adhesives, sealants, specialty rubbers, and plastics fields. Questions for publication should be directed to him at 242 Trails End, Aurora OH 44202; phone (440) 477-5164; or email DrDave242@windstream.net.

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3M's John Dugas shares details regarding the development process for medical adhesives, as well as a new silicone adhesive that has been developed for applications such as medical wearable devices.

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