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NOVEMBER 2022

#### MICROHARDNESS TESTING EXPLAINED 6

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#### Coating and Cutting and Curing, Oh My!



Angel Morris Editor

When planning this month's articles related to coating, cutting and curing, a famous movie line came to mind: "Lions and tigers and bears, oh my!" from the film, The Wizard of Oz. Today, that cliche is sometimes used to describe the feelings created when three things are partnered that bring about apprehension or awe.

In 1939, Dorothy, the Tin Man and the Scarecrow — played by Judy Garland, Jack Haley and Ray Bolger in Oz — made the phrase famous. The trio becomes frightened by noises while walking through the forest, and Tin Man suggests there are

probably lions and tigers and bears out there. Scarecrow and Dorothy nervously repeat the line, adding "Oh my!" to underscore their fright.

If you're a fan, you'll recall this is when our group meets the Cowardly Lion, who rounds out their journey to Oz crew. If you're not an Ozzy, the words coating and cutting and curing might instead bring to mind the preparation of Thanksgiving dinner (apropos this month!). There can certainly be feelings of apprehension for the person in charge of the biggest meal of the year ... followed by awe from those lucky enough to sit down to a table full of turkey, dressing and all the sides.

Since you're reading this, coating and cutting and curing undoubtedly are three Cs you more readily associate with the converting industry ... whether or not they bring to mind the man behind the curtain or meal prep of extraordinary proportions. In this issue, our experts reflect on methods currently available for online measurement of coating thickness, automating die-cutting for zero-fault production and the versatility of UV curing.

If your brain, like mine, makes odd connections between unrelated things, our cover story discussing two widely accepted methods of hardness testing -- Micro Vickers and Knoop -- is somewhat ironic. The *Wizard of Oz* is also a test of hardness, with the characters ultimately learning they each had what they needed all along.

In the words of the Great Oz: "All you need is confidence in yourself. There is no living thing that is not afraid when it faces danger. The true courage is in facing danger when you are afraid, and that kind of courage you have in plenty."

This month, may you have in plenty food, family and fellowship, oh my!

#### **Angel Morris**

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P.S. If you're interested in contributing a thought leadership piece from an industry expert perspective, please contact me at the email address above.

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#### A RDG Media, Inc. Publication P.O. Box 529 Estero, FL 33929 586.227.9344 www.pffc-online.com

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#### **MICROHARDNESS TESTING EXPLAINED:**

Vickers & Knoop Testing

By **Phil Eusebi**, Product and Applications Specialist, Industrial Physics

Tru-Blue MicroVT

Microhardness Testing is used to determine a material's hardness or resistance to deformation when test samples are not suitable for other types of Macrohardness testing. Microhardness testing is often used for evaluating hardness of very small or thin samples, irregular shaped samples, determining individual phases of a material, and surface properties of coatings and plating. Case depth hardness can also be measured.

While Macrohardness testing such as Rockwell, Macro Vickers and Brinell tests are common, these methods typically use larger applied loads in excess of 9.81 N (1 kgf). This may be inappropriate for materials or surfaces which are too thin relative to the indenter size, or where the properties of the surface are too delicate or brittle to sustain the large testing forces.

Materials and surfaces such as thin metal, metal coating or plating, micro weld, and adhesive joint lines, ceramics, or wide ranges of thin films or coatings, may exhibit erroneous data or undesirable failure or destruction under macrohardness testing methods.

Microhardness testing, on the other hand, uses microscopic indenter geometries and loads as low as 0.0980 N (10 gf) which are suitable for these same thin materials, coatings and plated surfaces, as well as small sample areas and surfaces that are delicate or brittle. Typically, microhardness testing uses a diamond indenter which is pushed into a surface under a defined load for a determined amount of time.

This process will generally leave an indentation in the surface, and this is then optically measured to determine the hardness value according to the appropriate indenter and testing scale (Vickers or Knoop).

Sample size, sample preparation and environment all must be considered when using a microhardness tester. This includes considerations such as room temperature and isolation from sources of outside vibration which may affect the results as well as proper sample preparation. There are two widely accepted methods for microhardness testing, both offering repeatable and accurate results: Micro Vickers hardness testing and Knoop hardness testing.

#### Micro Vickers Hardness Testing

The Micro Vickers hardness test uses a traditional Vickers type indenter, but at a microscopic scale. This indenter is a square-pyramidal shape and is typically pressed into the surface of the material for 10-12 seconds. The amount of force used is specified by the operator and varies depending on the materials being tested.

Once the test is completed the indentation left in the sample is analyzed optically to measure the lengths of the diagonals, which are used to calculate the size of the impression. Micro Vickers testing can be used for analyzing surface layers down to as thin as 60 microns.

#### **Knoop Hardness Testing**

Knoop hardness testing is similar to the Micro Vickers technique but uses an elongated-pyramidal shape indenter. In Knoop testing, the indenter is similarly forced into the surface of a sample to produce an indentation which can then be measured. Unlike the Vickers method, Knoop analyzes only the long axis of the indentation for calculating the hardness value.

The Knoop method is often preferred for testing using very low indentation force, and the shape of the probe makes it is suitable for samples needing indentations close together or on the edge of a sample. It can also offer higher



Tru-Blue Sample Cutter

levels of precision than the Vickers method, due to the fact the longitudinal diagonal of the indenter is greater. The same environmental and sample preparation requirements exist for successful Knoop testing as for the Micro Vickers technique.

#### Key Differences Between Vickers and Knoop

The most significant difference between Vickers and Knoop hardness testing is the design of the indenters. The Knoop indenter only penetrates the specimen about 1/4 as deep as the Micro Vickers indenter under identical force. However, for testing higher hardness surfaces or challenging specimens such as rounded surface areas, the Micro Vickers indenter may be more suitable.

#### Sample Preparation

**Sample Cutting** - Given that specimen sizes for microhardness testing and the size of the tester itself are small, it is common to



Tru-Blue Grinder Polisher

require cutting of samples down to a manageable size prior to mounting before polishing them in resin. Therefore, an additional piece of equipment specifically designed to cut samples will be required.

Sample Mounting - Mounting of the sample into a resin block prior to polishing is also a common procedure when performing microhardness testing. Mounting a sample is done by embedding the sample in a resin powder under high heat and pressure. Once the mounting process is complete a sample becomes embedded into a round disk consisting of a resin that surrounds the component being tested. The surface of the embedded sample can then be properly polished to ensure accurate testing results.

**Sample Polishing** – Because rough surfaces of a sample being tested may cause variation in results, it is often necessary to require polishing the surface of a sample before testing. Specialized pieces of equipment designed to polish samples are often found in Microhardness testing labs.

#### Microhardness Testing with Tru-Blue MicroVT

The United Testing Systems Tru-Blue range of microhardness testing machines offers both Micro Vickers and Knoop testing and is ideal for testing across a wide range of material types including metals and alloys, tin plating, solder and weld lines, automotive and marine paints and coatings, glass, ceramics and even plastics.

The MicroVT has a modular automated turret design to support an indenter and microscope objective, with a powerful imaging system and an intuitive, feature-rich user interface. The Tru-Blue MicroVT conforms to all international standards, including but not limited to ASTM E834,

#### ASTM E92, ISO 4546, ISO 6507 and ISO 9385.

United Testing Systems also offers a complete line of necessary accessories for specimen preparation. The Tru-Blue line of sample preparation equipment includes stand-alone Sample Cutter, a twin-station Grinder & Polisher and Sample Mounting press with both electro-mechanical and hydraulic pressurization options.

All Tru-Blue sample preparation units are robust and built for many years of reliable operation in demanding environments.

It is of the utmost importance to have your lab running smoothly and for your testing processes to be fast, accurate and repeatable – that's why testing machines manufactured by skilled experts using the highest quality components possible are key in microhardness testing. ■

#### ABOUT THE AUTHOR

Phil Eusebi is a Product and Applications Specialist with Industrial Physics, a global packaging, product and material test and inspection company. The group is made up of numerous specialist testing brands, including Testing Machines Inc., United Testing Systems, TQC Sheen, Ray-Ran, and many more. For almost 100 years, the team has been protecting the integrity of their customer's brands and products by providing world-class test and inspection solutions. Learn more at www. industrialphysics.com.



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### Methods for Closed Loop Coating Thickness Control

By Bob Pasquale, President, New Era Converting Machinery

There are many methods currently available for online measurement of coating thickness. A major benefit of these measurement systems is the ability to use the information to control the coating application in order to obtain a targeted laydown. This control can be performed in several ways, including:

- adjusting the speed of the coating application roll(s);
- adjusting the speed of the coating delivery pump;
- adjusting the speed of the web processing line;
- adjusting the coating gap; and,
- adjusting a combination of the above.

Quite often the coating method dictates which of the above methods is most desirable.

We will look at each of these methods, discussing how they are used to control the application rate, what types of coaters they are used with and how the thickness measurement system can be interfaced with them.

#### Adjusting the Speed of the Coating Application Roll(s)

There are several coating methods where the coating is transferred to the web using an applicator roll running in either the same Photo 1 – Kiss Coater.

or opposite direction of the web. In either method, adjusting the speed of the applicator roll directly affects the amount of coating that is applied.

Therefore, in these methods, the thickness measuring system's information is used to adjust the speed of the applicator roll to control the coating transfer. Examples of these coating methods include kiss coating (Photo 1) and offset gravure coating (Photo 2).

The ease with which today's drive and control systems can accurately control a motor's speed



Photo 2 – Offset Gravure Coater.

allows this method to implement highly accurate adjustments to the coating rate. Interfacing of the thickness gauge system with the drive system allows for fully automatic closed loop control of the application rate.

#### Adjusting the Speed of the Coating Delivery Pump

Certain coating methods apply a pre-metered amount of coating to the web through the use of a precision metering pump. In these cases the information from the thickness measuring system is used to speed up or slow down the pump in order to affect the amount of coating delivered to the web. Typical examples of this type of coater are slot die coaters (Photo 3) and spray coaters (Photo 4).

As previously discussed for the applicator rolls, the ability to control the motor's and therefore the pump's speed on a finite basis allows for making precise adjustments to the coating laydown rate as well as



Photo 3 – Slot Die Coater.



Photo 4 – Spray Coater.

automatically controlling the thickness via closed loop control.

#### Adjusting the Speed of the Web Processing Line

There are certain cases in which a pre-metered amount of coating is delivered to the web but it is not practical to change the rate at which the coating is being delivered to the process. This particularly applies to processes where the mixing or production of the coating is critical. In these, the information from the thickness measuring system is used to speed up or slow down the web speed in order to affect the amount of coating delivered to it. A typical example of this is extrusion coating.

Again, as in the previous two examples, today's drive and control systems can accurately control the speed of the system's motors, allowing for highly accurate adjustments to the coating rate. Interfacing of the thickness gauge system with the drive system allows for fully automatic closed loop control of the application rate.

#### Adjusting the Coating Gap

Several coating methods rely on a gap to control/meter the amount of coating applied to the substrate. This gap can take several forms



Photo 5 – Knife Coater.



Photo 7 – Between the Roll Coater with Closed Loop Gap Control.

including between two rolls or a roll and another metering device such as a knife blade.

In certain cases the gap between the two members is used to pre-meter the coating prior to it being introduced to the web while in other cases the coating is introduced to the web at the gap, resulting in the total thickness of the coating plus the web being metered.

In these types of coaters, adjusting the gap between the rolls or roll and knife changes the amount of coating that is applied. Therefore, in a closed loop system the information from the thickness measuring system is used



Photo 6 – Between-the-Roll Coater.



Photo 8 – Reverse Roll Coater with Closed Loop Speed and Gap Control.

to open or close the gap in order to affect the amount of coating delivered to the web. Examples of this type of coater are knife over roll (Photo 5) and between the roll coaters (Photo 6).

In these types of coaters, adjustable devices typically allow the gap to be varied. The information from a thickness measuring system can be used for closed loop control of these devices and therefore control the gap through the use of position-controlled motors that are tied to the devices as well as position feedback devices that monitor the gap. Such a system is shown above (Photo 7).

### Adjusting a Combination of the Above

In certain coating applications such as a reverse roll coater a combination of speed and gap control is used to control the amount of coating being applied to the web.

In this case the speed of the applicator roll is used for minor changes in the coating rate while larger changes are handled through adjustments to the gap between the rolls. In applications such as these a combination of the previously described methods of control is used to control the coating application rate. Such a system is shown here (Photo 8).

As demonstrated above, there are many different systems available that allow for the use of a thickness measurement system to control the application of a coating, with the type of coater dictating which method is most suited.

#### ABOUT THE AUTHOR

Bob Pasquale is co-founder and co-owner of New Era Converting Machinery, serving as president since 1996. He holds a degree in Mechanical Engineering and Metallurgy from Stevens Institute of Technology. Bob has been in the web converting machinery manufacturer business since college, working in many areas from technical sales to product development. He holds multiple patents related to web processing, currently serves as vice president on the AIMCAL board of directors and serves on the ICEC USA Steering Committee.

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# The Versatility of UV Curing

By Jennifer Heathcote, VP Business Development, GEW

UV curing is a versatile technology that enables inks, coatings, adhesives and extrusions to be set inline, in a small footprint and at high speed while also producing performance properties superior to what is achievable with conventionally dried materials.

This is because UV curing is not drying and is instead a chemical reaction initiated with ultraviolet energy. A reaction of this nature creates strong bonds between molecules and drives the creation of long polymer chains. To the observer, UV curing instantly transforms liquid-like materials that are wet-to-the touch into crosslinked solid polymers that are fully dry-to the touch.

UV formulations are 100 percent solids, contain no liquid carriers that must be evaporated and require no energy-consuming thermal dryers. This means UV curing processes are more environmentally friendly and produce less waste.

Once a web or sheet exits a UV curing station, it is immediately ready for further processing, converting, sheeting, slitting, rewinding and shipping. This keeps work-in-progress goods out of inventory.

Finally, UV cured surfaces do not scratch, mar or become damaged when passed through downstream manufacturing line components or finishing equipment. This reduces scrap and facilitates quicker lead times.

UV formulations are easily applied, cure in a fraction of a second and produce highly desirable and robust functional and aesthetic properties in final products. This facilitates use of UV processes across a wide range of printing, coating and converting applications. Examples are highlighted in Table 1.

#### **UV Curing Sources**

UV curing systems include mercury vapor, light emitting diode (LED) and excimer lamps. While each of these technologies emit ultraviolet energy, the mechanisms that generate UV energy, as well as characteristics of the corresponding UV output, are very different.

#### Mercury Vapor Lamps

Mercury vapor lamps are a type of medium-pressure, gas discharge lamp in which a small amount of elemental mercury and a specific mix of inert gas are vaporized into a plasma within a sealed quartz tube.

Table 1:	UV Curing	<b>Applications</b>	Employed b	y Web Converters

PRINTING INKS graphics text marking and coding flexible electronics	SPECIAL EFFECTS tactile haptic visual matte for anti-glare
PRESSURE SENSITIVE ADHESIVES (PSAS)	matte for stain resistance gloss
LAMINATING ADHESIVES	
COLD FOIL ADHESIVES	
CAST AND CURE COATINGS	COEFFICIENT OF FRICTION (COF)
OVER PRINT VARNISHES (OPVS)	anti-slip anti-skid
PRIMERS AND SIZE COATINGS	
LACQUERS	
SILICONE RELEASE	POLYMER EXTRUSIONS
HOTMELT ADHESIVES	INDUSTRIAL TOPCOATS, CLEARCOATS, HARDCOATS

Plasma is a high-temperature ionized gas capable of conducting electricity. It is produced inside an arc lamp by applying an electrical voltage between two electrodes within a sealed quartz tube.

Once vaporized, mercury plasma generates broad-spectrum UV output that radiates 360 degrees from the lamp. Specially designed reflectors located behind the quartz tube are used to concentrate emitted UV energy onto webs, sheets or parts. UV curing systems utilizing mercury vapor lamps are cooled with forced air and/or circulated liquid. Mercury vapor lamps have a short warm-up and cool-down period that occurs each time they are switched on or off. An image of several mercury arc lamps and a lamphead assembly is provided in Figure 1 (a).

#### UV LED Lamps

LED lamps are solid-state electronics composed of numerous chips of thin, semi-conductive, crystalline materials electrically wired together in a single row or a combination of rows and columns. In the case of UV LEDs, precisely designed and fabricated gallium nitride (GaN) and aluminum. gallium, nitride (AlGaN) materials emit relatively narrow wavelength bands of ultraviolet energy when connected to a DC power source. The emitted light has a peak output centered at 365, 385, 395 or 405 nm, is projected forward from each LED a full 180 degrees, is quickly and easily turned on or off and has full linear adjustment of power. UV LEDs do not contain elemental mercury.

Each discrete LED is referred to as a positive-negative junction

(p-n junction). This means that one portion of the LED has a positive charge, referred to as the anode (+). The other portion has a negative charge, referred to as the cathode (-).

When connected to a DC voltage power supply, free electrons in the n-type region cross over and fill vacancies in the p-type region. As electrons flow across the boundary, they transition to a state of lower energy.

The respective drop in energy is released from the semiconductor as a combination of UV photons and heat. The heat is due to electrical inefficiencies in the device. Typically, up to 40 percent of the differential is emitted as photons. The balance is converted into heat that must be removed from the system.

An illustration of three LED

Figure 1: Types of UV curing systems.



modules integrated into a much longer linear array with numerous modules as well as a corresponding lamphead assembly is provided in Figure 1 (b). Each of the purple squares in the graphic represents a single LED.

Engineers package and power LEDs to emit the desired UV output for the intended market segment and application. Lamphead assemblies are then cooled with forced air or circulated liquid to maintain the necessary device operating temperate, remove waste heat and ensure performance longevity.

#### Excimer Lamps

Like mercury vapor lamps, excimer lamps are a type of gas discharge lamp. Unlike broadband mercury

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vapor lamps, excimer lamps emit narrow bands of ultraviolet energy without the use of elemental mercury. Excimer lamps are commonly available with ultraviolet outputs centered at 172, 222, 308 and 351 nm. 172 nm excimer lamps fall between 100 and 200 nm which is known as vacuum UV (VUV).

The VUV band contains the shortest wavelengths of ultraviolet light. These wavelengths are entirely absorbed by oxygen and do not travel through air. As a result, when 172 and 222 nm excimer lamps are used for curing, they are always integrated with nitrogen inertion that pushes atmospheric air away from the gap between the lamp and curing surface and replaces it with nitrogen.

Another feature of wave-

#### Different gases produce different excited molecules and determine which specific wavelengths are emitted by the lamp.

lengths below 240 nm is that they generate ozone (O3) when absorbed by oxygen molecules (O2). Ozone generation is prevented through proper nitrogen inertion. Photons of vacuum UV contain more energy than those of longer UV wavelengths but are only effective at curing the outermost surface of UV formulations. In fact, 172 nm wavelengths are completely absorbed within the first 10 to 200 nm of UV formulated chemistry.

As a result, 172 nm excimer lamps must always be integrated in combination with mercury or LED systems to achieve full depth of cure. Because the surface is crosslinked separately from the rest of the formulation, excimer UV curing is uniquely effective at creating matte surfaces that are anti-reflective, anti-glare and anti-fingerprint.

Excimer lamps consist of a quartz tube which serves as a dielectric barrier. The tube is filled with rare gases capable of forming excimer or exciplex molecules. Different gases produce different excited molecules and determine which specific wavelengths are emitted by the lamp.

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A coiled electrode runs along the inside length of the quartz tube while ground electrodes run along the outside length. Voltage is pulsed into the lamp at high frequencies. This causes electrons to flow within the internal electrode and discharge across the gas mixture toward the external ground electrodes.

This scientific phenomenon is known as dielectric barrier discharge (DBD). As electrons travel through the gas, they interact with atoms and create energized or ionized species that produce excimer or exciplex molecules.

Excimer and exciplex molecules have an incredibly short life. As they decompose from an excited state to a ground state, a narrow band of photons are emitted. Excimer lamps generate UV curing is practical for inkjet, flexo, gravure, screen, rotary screen, litho, offset, slot-die, Mayer-rod, roller and curtain coaters, and spray among many other transfer and deposition methods.

negligible heat and require little if any lamphead assembly cooling. An image of an excimer lamp and corresponding lamphead is provided in Figure 1 (c).

UV curing is practical for inkjet, flexo, gravure, screen, rotary screen, litho, offset, slot-die, Mayer-rod, roller and curtain coaters, and spray among many other transfer and deposition methods. Mercury arc lamps are available in lengths up to 2.5 meters; LED UV lamps in lengths up to 1.7 meters; and excimer lamps in lengths up to 2.3 meters. ■

#### ABOUT THE AUTHOR

As GEW's VP Business Development, Jennifer Heathcote is a leading authority on conventional and UV LED technology, as well as their use across a broad range of industrial curing and graphic printing applications. To find out more about UV curing products and how they benefit printers, coaters and converters, visit www.gewuv.com.

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#### DIE CUTTING



### Automating the Die-cutting Process for Zero-fault Production

By Douglas B. Herr, Director of Sales, Folding Carton, BOBST

The vision of a sustainable future is one where fault-free folding cartons and corrugated boxes are produced by highly automated printing and converting lines controlled by centrally stored data and digitally connected throughout the entire value chain.

As we continue to move away from manual intervention to reduce waste-creating errors and speed up production, flatbed die-cutting technology must be optimized to allow for higher productivity and cost-efficient manufacturing of fibre-based packaging, so converters can respond with confidence to the market trends of today and tomorrow.

#### Market trends to consider

The packaging market is driven by a number of trends that influence the manufacturing of folding cartons and corrugated boxes. The continued growth in e-commerce, the accelerating demand for sustainable packaging, and the request for faster time-to-market, mean converters are facing unprecedented pressures to deliver high quality at top speed in shorter runs with less waste, whilst also being equipped to handle new types of board with more recycled content.

E-commerce has changed packaging dynamics. The global market in 2022 is estimated to be worth \$63.6 million having seen a sharp rise with annual growth rates of 20 percent between 2017 and 2021, according to the *Smithers Report, The Future of E-commerce Packaging to 2027*. However, this level seems to be calming down from the manic days of the pandemic to around 12.5 percent in 2022. Growth is predicted to continue, and even though this will be at a steadier rate of just under 10 percent CAGR, it still presents huge opportunities for printers and converters.

Coupled with the e-commerce trend is the "unboxing" experience, where consumers share the moment when they open the package with an online audience on social media. This puts the packaging on stage in front of thousands of potential customers, allowing them to evaluate both how it looks and how it performs.



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Consequently, brand owners are constantly looking to improve this experience with memorable packaging that stands out, which is driving the trend for inside-outside printing.

Sustainability is at the forefront of every brand owner's mind as they pledge to lower their impact on the planet. Many are turning to fibre-based solutions in response to consumers' concerns over plastic waste and to comply with new legislation, which are increasing the demand for sustainable packaging solutions and putting more pressure on the supply chain. Shorter production runs and often changing designs are the order of the day, and this requires greater agility and higher productivity from the converter.



### Productive, versatile and cost-efficient production

Today's die-cutting technology, whether it is part of an inline box-making solution or presented as a standalone machine, is built to offer exceptional cutting capabilities with minimal waste. Blanks must be precisely cut and in full register in order to pass the inspection and avoid being discarded.

Featuring a host of solutions that automated each function, from feeding to final stacking, large format converting lines that combine flexo printing with flatbed die-cutting are ideally suited to producing e-commerce solutions. They come with integrated 100 percent quality control inspection that closes the loop from artwork design to the final product, thereby reducing costly production recalls and consequently waste.

Some of the latest innovations in this space include more advanced feeder technology that reduces board compression by up to 15 percent, making it possible to handle lighter board types that lower the total weight of paper in each packaging unit, which minimizes the environmental footprint and cost.

Meanwhile automated setup functions can control and correct all parameters to cut down on the number of boards required to initialize each job and the time it takes to begin producing sellable output. We are also seeing new solutions that can die-cut a much wider range of board thicknesses, so folding cartons and corrugated boxes can be converted on the same machine for greater production flexibility.

For folding cartons, new automated cutting plate adjustment where a motorized micrometric system can center the thin cutting plate to the die has been developed to ensure the perfect match between the cut and the creasing positioning. This removes the need for the operator to perform the more usual manual alignment and allows settings to be stored for repeat jobs.

Meanwhile, offline quality control solutions, such as digital inspection tables, can proactively reduce make-readies and the time

### Want More Production?



it takes to check the job to further boost productivity. By automatically capturing data, they can also enable production improvements through data-driven insights.

#### Connectivity is the future

As mentioned, the future vision of packaging production calls for the entire packaging value chain not only to be automated and digitalized, but also fully connected to give clear visibility of all processes to converters and brand owners alike. Remote job setup will become the norm using the data in the artwork PDF file to further shorten set up times.

However, efficiency is not everything; Quality must be high and at a consistent level, which is why every detail matters. Tooling is an often overlooked and under-estimated part of die-cutting but by investing in high performance tooling from certified die-makers, converters can ensure that their flatbed die-cutter reaches its true potential.

Furthermore, the tools can be connected with the machine via a chip, so that job data can be exchanged in seconds, which will significantly reduce machine downtime during a setup.

Another advantage of full connectivity is the ability to constantly monitor each machine so preventative maintenance can be put into action to avoid potential issues that can affect efficiency and uptime. Only by having complete overview of the production floor through connectivity and data analysis can converters eliminate bottlenecks and eradicate waste to optimize their operation.

#### In conclusion

To meet the market challenges discussed, converters must implement high levels of automation to improve efficiency so they can increase the quantity of sellable production over time and reduce the cost per unit. They must also produce in a sustainable manner as demanded by consumers and brand owners as well as new legislative requirements.

With on-board automation shortening makeready requirements and fulfilling faster time-to-market expectations, while connected and digitalized solutions are delivering controlled and sustainable operation, we are on the road to zero-fault production. This vision will in part be powered by innovative and versatile die-cutting solutions.

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96252	2.5"	64 mm	59 mm	Orange	.118" (3.0 mm)	\$1.85
96302	3.0"	76 mm	70 mm	Orange	.080" (2.0 mm)	\$1.85
96402	4.0"	102 mm	95 mm	Orange	.080" (2.0 mm)	\$2.25
96602	6.0"	152 mm	141 mm	Orange	.095" (2.4 mm)	\$3.15
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### The Value of Atmospheric Plasma

Improving Adhesion on Thermally Sensitive Materials, Thick Materials, Embedded Electronics, Foam and Panels from SOFTAL Corona & Plasma

Surface treatment technology has been widely used for decades to modify substrates' surface energy for improved adhesion of inks, lacquers, adhesives and coatings. Corona treatment is the most popular method in the plastic film, extrusion and converting industries. It is economical and adaptable to many applications such as highspeed printing presses, blown film applications and extrusion coating lines.

Despite the popularity of corona treatment, there are limitations. Materials to be treated can only be a few millimeters in thickness. Heat generated from the corona discharge can damage delicate materials. And, embedded circuitry cannot be treated due to the electrical discharge of the corona treatment.

#### SOFTAL's Plasma Treatment Solution

With these limitations in mind, Hamburg-based SOFTAL Corona & Plasma developed its patented Linear Plasma system designed to raise the surface energy and adhesion properties of a wide variety of substrates.

SOFTAL's atmospheric plasma system uses a technology similar to corona treatment, however Linear Plasma has the ability to process delicate substrates due to its lower temperature without the drawbacks of other surface treatment methods, such as streamers and heat damage, perforation and flawed edges. Importantly, designed without a counter electrode, there are no restrictions on a substrate's thickness or makeup.



LinearPlasma treats foam at 10mm thickness.

#### Linear Plasma's Capabilities -Materials and Applications

Linear Plasma opens up numerous surface treating applications such as polymer foam, extruded boards, sheets, panels (up to 2 meters wide) and more. Beyond increasing surface energy and promoting powerful adhesion, atmospheric plasma cleans surfaces to remove contamination. Additionally, SOFTAL's Linear Plasma produces a voltage-free discharge - important for the treatment of printed and embedded electronics. Figure 1

Linear Plasma Improves Adhesion on These Materials and Applications:

- Thick polymer sheets
- Foam, open and closed pore
- Honeycomb structures

- Glass plates
- Composites
- Optical Film
- Thermally sensitive film
- Embedded electronics
- Multiwall panels
- Paper board

#### Other Benefits of Linear Plasma

Linear Plasma is easy to use, maintain and integrate into production lines. It provides repeatable, process-controlled operation, with high efficiency and low operating costs. Linear Plasma is environmentally friendly because treated surfaces are hydrophilic with "green" water-based paints, inks and adhesives eliminating chemical primers. Additionally, plasma is safer in the workplace than flame surface treatment.

#### SOFTAL's Corona & Plasma – Adhesion Guaranteed

SOFTAL Corona & Plasma produces a full range of powerful, dependable surface treatment systems for treating materials from 10 inches to 10 meters. More than 60 years of experience has made SOFTAL a world leader in surface treatment technology.

SOFTAL is represented in North America by 3DT LLC of Germantown, Wisconsin. 3DT manufactures a broad line of surface treatment systems, all customizable for unique applications. For more information, contact sales@3DTLLC.com or visit our website at www.3DTLLC.com.



Figure 1: Linear Plasma from SOFTAL provides surface treatment solutions for thick, wide, thermally sensitive materials and more.







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While the industry is working to sustainable solutions to serve the flexible packaging industry, the demand for conventional packaging is under constant growth. The driver is mainly the need to reduce food waste by extending shelf life. The task to extend shelf life is accomplished mainly by higher barrier properties of the packaging. This is in act the driver for the growth in orders of 3-ply laminators single pass we have experienced in the past 3 years. One segment of this machine set up those records a remarkable rise is the one of 3-ply solvent less laminators. This is a segment Nordmeccanica has served since the 90s with innovations that gave to the industry the flexibility to approach such conversion process in total reliability. Triplex Compact SL was the machine set up that allowed to approach the task since 1994. Machine has been sold prevalently in Europe to converters involved mainly in coffee packaging. A typical coffee lamination structure was in fact: PET - FOIL - LDPE. It was the pass PET-FOIL to offer the side effect of CO2 entrapment and consequently to influence the overall process speed. In any case the constant use of the same process recipe allowed to configure a machine set up suitable for easy set up at back to back job. Experience and process development informed smart adhesive approach among converters: High Performance high viscosity (and consequently expensive) adhesive on the PET-FOIL pass and a generic SL formulation for the second pass, second pass that was easier to handle because of the short path between the lamination nip and the rewind. The machine set-up remained the state of the



Triplex Compact SL



Triplex SL One Shot™

art for the following 15 years. Then the configuration developed as obsolete influenced by features that, as the lamination technology was growing, required rethink and innovation. The webbing set up in example featured an extremely long path with the consequence to affect process scrap; the speed limitation due to CO2 entrapment influenced by the close set up of coating and lamination nip; the ever-decreasing viscosity of new adhesive formulations introduced to the market that, at a lower viscosity, influenced the sheer resistance negatively.

To overcome all of the above Nordmeccanica presented to the industry Triplex SL One Shot<sup>™</sup>. The patented innovation features 2 coating stations, one only lamination nip, and is designed to accept any set up of unwinds and rewinds in our product range. The coating

station location allowed to coat the two outer webs in the 3-ply structure with the additional benefit to overcome any potential pinhole problem on foil. The configuration has been serving as well alternative industries allowing to laminate 3-ply structures incorporating as middle web a reinforcement synthetic mesh. One of the greatest benefits of the configuration of the Triplex One Shot being the extremely short web path allowing to save significant amounts of scraps at start up versus more traditional configurations.

Triplex SL One Shot<sup>™</sup> with its remarkable energy saving set up and its unique configuration is "the" technical solution to convert 3-ply structures at the highest level of quality, productivity and cost reduction.

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#### HOW TO: Know When It's Too Late to Buy QC Equipment

Why do so many converters look at quality control products for your manufacturing process only after there is a problem? As a manufacturer of web guiding and QC inspection systems, we frequently receive calls only after an issue has occurred, resulting in a substantial financial loss and a significant dent in your company's revenues. This has often been referred to as a defensive purchase. Defensive because you either cannot afford another costly QC issue or your customer has stated that you must fix the problem or lose their business, BST North America manufactures a wide assortment of products that are designed to mitigate any future QC issues you may encounter, such as web guiding



equipment with the most sophisticated sensors and controllers to ensure your product is produced with precise accuracy. We also manufacture print and surface inspection equipment, which ensures that the product's quality is within the tolerances you specify from start to finish.

All too often, older equipment relies on outdated web guides that simply cannot perform as well as they did when you purchased them. Time to update!

Quality control equipment should never be a defensive purchase because it already cost you money. If you look at this as an offensive purchase, it will ensure the highest quality of products leaving your plant, and your customers will be far more satisfied. So, how much will it cost you not to invest, or how much has it cost you for not investing?

For more information on BST web guiding systems, please contact Paul Henke at "Paul. Henke@BST.group" and for more information of inspection systems, please contact Ernest Schneider at "Ernest.Schneider@BST.group".





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#### **HOW TO GUIDE**



### HOW TO: Combine the Capabilities of a Duplex Center Winder with the Productivity wGains of a Turret

#### Introducing the Catbridge 900MC: The best of both worlds

The innovative 900MC combines the capabilities of a duplex center winder with the productivity gains of a turret. The 900MC can rewind to a 32" diameter and will handle materials including paper, primary films, flexible packaging laminations, pressure sensitives, and label stock. To significantly reduce downtime between sets, this duplex center winder uses auto tabbing and auto cut and transfer technologies. Cutoff is done close to the rewind point, producing short strands that can be precisely controlled for roll alignment. Additionally, this machine offers proven technologies that increase production including auto knife positioning and auto core loading. For ease of use, the 900MC provides an advanced yet intuitive control system and an ergonomically-friendly design.

#### **Key Features**

- The simplicity of a duplex center winder & the advantages of a turret
- 32" rewind diameter & auto cutoff and transfer
- Friendly ergonomics & increased throughput
- Automatic knife positioning & tabbing, core loading
- Slits close to the winding point & multiple slitting methods



The 900MC is ideal for flexible packaging and label applications.

#### **Standard Features**

- 32" (813 mm) diameter duplex rewind
- Web widths up to 62" (1575 mm)
- Speeds up to 2500 fpm (763 m/min)
- Shafted or shaftless unwind
- Center rewinding on cantilevered, differential shafts
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Catbridge manufactures high-performance slitter rewinders for diverse industries and applications. We build a complete line of center, center-surface, and surface slitter rewinders that efficiently convert a broad range of materials. Catbridge incorporates state-of-the-art technologies for significant gains in productivity, slit width control, and finished roll quality

Catbridge is different. Unlike many of our competitors, we conceptualize, engineer, build, program, calibrate and tune every piece of equipment we sell-with customer input playing a role throughout. Catbridge provides extensive production analysis to identify the best solution for your business.

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#### HOW TO: Mark Defects Safely and Automatically

Let's face it. Despite your best efforts to eliminate it, scrap happens. And when it does, you need to always know where it happened so you can find and remove it before it reaches your customer.

Maybe you insert a slip of paper into the winding roll, or hand apply a pressure sensitive label to the moving web, or possibly use a felt pen. These too often used manual practices are extremely dangerous and result in countless injuries. As a result, many lines are now equipped with guarding and interlocks making it impossible for operators to access the moving web.

Not only is hand marking webs an unsafe practice, but it is inaccurate and costly as well. By the time a defect is noticed and the web is hand marked, yards of defective product can pass, resulting in wasted time and product when removing the bad material downstream.

Maybe you "remember" where scrap is with digital roll maps which are used to locate and identify scrap. These systems work well until material is removed from the roll. If you slab off damaged material on the outside of the roll or you remove scrap



Novation AF3 WebFlaggers can apply colored or barcoded flags for marking and tracking.



Keep hands away from moving machinery with automatic flagging.

within the roll, some physical marker is required to then resynchronize with the roll map.

So, how can one safely and accurately mark defects, and also track scrap? Automatic web marking offers a solution.

Novation's WebFlaggers safely, accurately, and automatically place pressure sensitive labels on webs at any process speed. A portion of the label has no adhesive and hangs off the edge of the web like a "flag" making it visible in wound rolls. They can be triggered manually, from inspection systems, or from any machine signal.

WebFlaggers can also be combined with digital roll mapping to solve the resynchronization problem mentioned above. Novation's AF3 WebFlagger can be integrated with most all roll mapping systems as well as their own.

Novation's ScrapTracker system applies pre-printed, numbered, bar-coded flags and creates roll maps with each flag ID number, defect location, amount and type. This data file can be printed as a report or uploaded to plant LAN or any data storage device. The data in the roll map can be used to help identify the type of defect to be inspected and/ or removed or to create custom reports for scrap. These reports aid in process improvement and scrap reduction programs.

Novation has been serving the printing and converting industries since 2002. They are a world leader in safety and waste reduction through the automatic marking and tracking of defects. Novation's WebFlaggers have become an industry standard. Novation's products have been an integral part of safety of waste management programs implemented by some of the world's largest corporations. Their customers supply markets such as flexible packaging, electronics, automotive, films, tapes, non-wovens, healthcare and hygiene products and more. With almost two thousand installations worldwide, Novation's equipment has marked hundreds of millions of defects. All Novation products are designed and manufactured in their plant in Bethlehem, PA.

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#### **Q&A:** Paul Lembo of New Era Converting Machinery

New Era is a global enterprise focused on providing custom designed equipment solutions for the web handling industry. With decades of industry experience on staff, New Era can apply its engineered solutions to provide customers with web handling equipment tailored to their converting needs. New Era has a great deal of experience with coating, laminating, calendering and drying systems for a wide variety of environments, with a customer base spanning most industries which handle materials in a roll-to-roll fashion. Paul Lembo, Executive Vice President at New Era Converting Machinery, Inc. recently took some time to discuss the company's diverse experience in the battery and energy space. Here is what he had to say:

#### What specific types of applications has New Era provided for machinery solutions for the battery market?

New Era's web handling experience with nearly any material which can be handled in roll-to-roll format has provided the tools for us to be competitive in several market segments, all parts of which are important to battery production. New Era designs and manufactures pilot and production equipment for electrode coating, separator materials and vibration dampening/thermal foams such as polyurethane and silicone. Our vast experience in coating, laminating, calendering and general web handling has positioned us well to be a major player in all of these areas of energy storage component materials.

Are there any unique challenges you've seen that battery applications require, or are they



#### similar to most other converting applications?

One of the great things about our industry is that almost every new project has unique challenges, making the need for a wide range of past experiences to lean on even more important. From a process perspective, integrating new technologies and learning how everyone fits into the market will be one challenge. On the production side, converting companies who are used to building one-off pieces of equipment will be challenged to ramp up their production capacities, as many customers in the energy space require multiple equipment lines in order to meet their production needs.

#### As the battery market continues to grow, what do you see coming for new or different converting applications?

I see converting machinery manufacturers being challenged to offer a range of integrated subsystems outside of traditional roll-to-roll converting equipment to provide clients with a sole source, and more importantly, a single integrator for process lines. Converting equipment manufacturers are being asked to provide and integrate mixing/delivery systems, automate input and output roll handling and even provide robotic solutions for material and part handling. In fact, The Battery Show in Novi, MI this past September brought together a lot of these industry players who in the past have stood alone in their efforts to sell systems to their clients. We exhibited at the show for the first time and it was excellent.

#### How much of New Era's current business would you say is related to battery/EV market applications? Do you see that growing over the next few years?

As mentioned above, New Era is involved in a wide range of battery and energy storage input material processes. While this is a large component of our overall business, we are still heavily involved in adhesive tapes, aerospace, membrane/filtration media and construction products such as moisture barriers and roofing materials, to name a few. As far as growth over the coming years, the outlook for the battery market as far as volume of new equipment installations is as bright as anything I can remember. With the number of emerging technologies, all with their own unique needs from a coating and web handling perspective, we are only just getting started.

#### With all the potential opportunities that this market provides, does New Era plan on growing or expanding to keep up with the new business?

New Era has been growing steadily over the past few years and recently added a second manufacturing facility in Paterson, NJ, not far from our headquarters. We continue to look for good people as well as evaluate opportunities for additional physical expansion.



#### **Battery Material Production Equipment**

New Era is a leading converting machinery manufacturer in the battery space due to its vast experience with a wide range of materials which are used in energy storage. Our web handling experience with nearly any material which can be handled in roll-to-roll format has provided the tools for New Era to be competitive in several market segments, all parts of which are important to battery production. New Era designs and manufactures pilot and production equipment for electrode coating, separator films, and foams such as polyurethane and silicone. Our vast experience in coating, laminating, calendering and general web handling has positioned us well as a major player in all of these areas of energy storage component materials.

For more information on these and other systems, please contact us by phone, email or through our online portal.

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### For Composite Packaging Recycling, the Future is Now

As we move toward a circular economy, the technology now exists to separate and repurpose materials from combination packages.

By Thorsten Hornung, CEO, Saperatec GmbH

Over the past few decades, the end user packaging materials consumption rate – that is, the amount of packaging that winds up being used and discarded by consumers – has steadily risen. In my home country of Germany, for example, this concerning figure has climbed 13.5 percent since 1991<sup>1</sup>.

That's a lot – and it could have been far worse. Without consistent materials science innovations and progress in packaging material optimization, packaging resource consumption would have jumped more than 33 percent in that same period. Among other improvements, advancements like lightweight flexible packaging and composite packaging material structures have enabled significant reductions in packaging weight (and therefore resource consumption) – even while enhancing protection for packaged goods.

Often, these advancements strike a delicate balance between sustainability and product protection, but the goals are clearly defined by sound science. For example, a study<sup>2</sup> by the Institut für Energie- und Umweltforschung Heidelberg (IFEU) shows

that substituting rigid packaging materials with lightweight flexible packaging materials could reduce global warming potential by 32.9 percent, even though current material recycling rates for flexible packaging are far lower than for rigid packaging materials (glass, metal and rigid plastics). Conversely, replacing existing flexible packaging with rigid packaging materials would increase global warming potential as much as 31.1 percent - a figure that is, simply, unacceptable given the current climate landscape.

However, there's a catch: flex-

ible packaging materials typically require special barrier layers to adequately protect packaged food and reduce food waste. As a result, packaging designs often combine different polymers such as PET, PA, EVOH and polyolefins, and complement these polymer films with metal layers like aluminum foil or vacuum metallization.

In another study, IFEU compared the life cycles of certain packaging structures for pasta sauce and olives<sup>3</sup>. In these case studies the CO<sub>2</sub> equivalent emissions of aluminum foil/plastics composite packaging was estimated at 63–72 percent lower than rigid glass or metal packaging – even though, today, only aluminum foil is generally recycled from such composite packaging materials.

The research points to one long-term challenge as an obstacle: the ability to recycle a wider variety of composite (materials combination) packaging solutions would bring sweeping improvement to overall packaging sustainability efforts. Unfortunately, currently the vast majority of multi-material composite packaging materials end up in landfills or incineration centers.

Encouragingly, though, novel recycling methods such as delamination recycling – that is, separating the individual materials comprising composite packaging - bring the promise of addressing this concern across several types of common composite packaging materials. Among other structures, delamination recycling could be a game-changer for the recycling of beverage carton packaging; flexible packaging materials with aluminum foil and metallized coatings; tube packaging with aluminum layers; and even pharmaceutical packaging with aluminum layers.

With delamination recycling, multi-layer materials like polymer, metal and glass are treated in a hot wash process using a specially formulated separation fluid. This separation fluid enters the boundary layers between the differing materials and de-bonds them into separate particles without dissolving them. Once successfully separated, mechanical recycling technology can sort and refine polymers, metals and glass into separate material fractions for recirculation.

The technology, then, now exists to bring delaminated and



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repurposed materials to industrial maturity. The potential strides toward a fully circular economy are enormous. The ability to recover polyolefin plastics at high quality, then produce film-grade recycled plastics for packaging applications, will create avenues for recycling that did not previously exist. For example, a current project is repurposing post-consumer LDPE from beverage cartons for utilization in non-food consumer packaging.

In composite packaging featuring aluminum, the new delamination recycling can recover these metallic layers with a metal purity of over 95 percent, with

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Web: printco-industries.com E-Mail: sales@printco-industries.com oxidation kept below 2 percent. This end product is suitable for recirculation into foil applications and other packaging solutions as a replacement for virgin aluminum.

Crucially, all chemicals used in the process comply with EU food-contact regulations. In addition, the process itself is designed for sustainability, as the separation fluid is recirculated more than 30 times before being sustainably discarded.

Through delamination recycling, composite packaging materials with aluminum foil and other metallized barriers are uniquely positioned to contribute to overall packaging materials sustainability, for a variety of reasons. For one, aluminum foil is the most effective barrier material in packaging applications, especially in high-leverage, barrier-dependent applications like pharmaceutical packaging and certain types of food outside the cold-chain. Another factor is that lightweight packaging materials with effective barriers can contribute significantly to greenhouse gas mitigation, especially in high-population, developing nations with less sophisticated cold chains suitable for mono-material packaging.

Third, packaging materials with aluminum foil layers can be effectively sorted from other types of packaging materials through standard eddy-current sorting, allowing them to be efficiently supplied to suitable recycling treatment. Delamination recycling recovers both aluminum and polymers from such packaging materials for recirculation – an unprecedented whole-package approach.

Finally, delamination recycling is a physical recycling process that keeps plastics materials intact, and enables recycling with energy and greenhouse gas efficiency comparable to other advanced mechanical recycling processes.



- Change of consumption of all types of end consumer packaging materials in tons/year between 1991-2020 according to "Entwicklung von Konsumverhalten, Aufkommen und Materialeffizienz von Verpackungen", Kurt Schüler, Gesellschaft für Verpackungsmarktforschung mbH, 2022
- 2 'Potential packaging waste prevention by the usage of flexible packaging and its consequences for the environment', ifeu, Heidelberg, November, 2019, commissioned by Flexible Packaging Europe (FPE)
- 3 'Comparative Life Cycle Assessment of different pouches and alternative packaging systems for food (Pasta Sauce and Olives) on the European market', ifeu, Heidelberg, April 2021, commissioned by Flexible Packaging Europe (FPE)

#### ABOUT THE AUTHOR

Thorsten Hornung is CEO of Saperatec GmbH, which develops wet-mechanical recycling processes for thin-layer composite materials made of plastic, metal and glass. At its site in Dessau in Saxony-Anhalt, Germany, the company is building its first recycling plant for composite packaging made of plastic and aluminum. The plant is scheduled to commence operations in 2023, with an initial goal of processing 18,000 tons of packaging waste. Through technology advancements, the company aims to make important contributions to improving the sustainability of high-performance composite materials. www.saperatec.de/en.



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