



Thermoforming Quarterly®

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IN THIS ISSUE:

ETD Conference Review

SPE Salary Survey 2018

Multilayer EVOH/HDPE Packaging

Twin-Screw Extrusion Systems for Bioplastics

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■ Departments

Chairman's Corner | 4

Thermoforming in the News | 8-11

The Business of Thermoforming: North America
Thermoformed Package Market Analysis | 12-17

Thermoforming & Sustainability: Twin Screw Extrusion
System Developments To Process Bioplastics | 34-36

University News | 45

■ Features

Multilayer EVOH/HDPE Packaging in Processing and
Performance of Recycled HDPE | 18-25

Industry Practice: European Thermoforming
Conference | 26-32

Foamed PET Sheet for Cups
for Hot-fill Applications | 40

■ In This Issue

Global Dispatches | 42

SPE Council Summary | 43-44



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A Case For Change

It is my honor to address you for the first time as your new Chairman of the Thermoforming Division. By way of introduction, I started on the board back in 2010 when Gwen Mathis, our esteemed matron and conference coordinator for many years, suggested that I step up and serve, though this was probably just her way of throwing some 'fresh meat' to the old guard. I have operated in several positions: Chair-Elect, Executive Committee (2015 – 2018); Secretary (2013 – 2015); and Conference Committee Co-Chair (Atlanta – 2013). Prior to joining the board, I was involved with the conference as an exhibitor and supplier since 2000. That's it for the introductions. Let's get down to business.

A Case for Change

Our board is composed of the entire thermoforming value chain. As market participants, we could see that broad awareness of the benefits and value proposition of thermoforming vs. other processes was weak. Industry growth was not keeping up with other competitive options; conference attendance was flat; membership was flat or declining. As business-minded folks we asked ourselves a few simple, but difficult questions: "What do we do to grow again?" "What actions do we take to bring greater awareness and value of the thermoforming process to our industry and, more specifically, our membership?" We sought to understand, appreciate and preserve what is working, and we planned to adjust and fix what is not.

Taking Action

In early 2016, we decided that to get better results, we had to do things differently. Using our division's mission statement*, we developed committees focused on the advancement of our industry and technology in 3 areas:

- 1. Education:** develop, gather, & document a collection of base knowledge, demystify the art, amp up our exposure and support to high schools, trade schools, and colleges.
- 2. Research & Development:** attack challenges and issues facing the industry from a technical standpoint.
- 3. Promotion:** refine the value proposition of the thermoforming process and the industry; improve awareness.

It is said that you can't manage what you can't measure. We have now established goals for ourselves with conference attendance, membership growth and retention. On the education side, since January of last year, we have funded nearly \$90,000 for several thermoforming machines



Eric Short



to various colleges. At NPE in Orlando, Division grant money helped to fund 130 local high school students to attend the expo.

On the R&D side, content from the group's efforts led directly to two separate panel discussions of experts at our upcoming conference in Ft. Worth in September. Several key technical topics are being pursued for articles and speakers in the future, such as design trends, lightweighting, and automation.

From a promotional perspective, we've diligently worked on our elevator pitch to answer, "why thermoforming?" This messaging was used at the Industrial Design Society Association (IDSA) international conference for the last two years, promoting the industry and the process to several hundred designers from household names such as Pepsi, Apple, and General Electric to name a few. Currently, we're working on membership-value enhancement, pursuing content that would be accessible only to members of the Division.

Looking Forward to Ft. Worth

Although Mother Nature kept us from Orlando last year and we unfortunately had to cancel the event, we're looking forward to bouncing back this year in Ft. Worth. This will be the first time we've hosted our flagship conference in Texas. We have some great content this year, from the always-popular processing workshops, to presentations by John Deere and Stratasys, to a talk on how to motivate millennials, not to mention over 60 exhibitors to connect with on the latest and greatest in products, innovations, technology and services (and much, much more!!)

And last, but certainly not least, we plan to enhance your Lone Star State experience with another first: our Awards Banquet is being held at AT&T Stadium, home of the Dallas Cowboys! You don't have to be a Cowboys fan to know that this is one conference you don't want to miss! I look forward to seeing you there.

* *Our mission is to facilitate the advancement of thermoforming technologies through education, application, promotion and research. |*

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Sonoco Products Buying Florida-based Thermoformer

by Jim Johnson, *Plastics News*

March 22, 2018 – Sonoco Products Co. is expanding its PET thermoforming business with the acquisition of a Florida-based packaging maker.

The Hartsville, S.C.-headquartered company struck a \$150 million deal for Highland Packaging Solutions Inc. of Plant City, Fla.

The purchase brings \$90 million of annual business to Sonoco through one production facility and five warehouse locations in the Southeast and on the West Coast.

Buying Highland gives Sonoco an entry into the egg packaging market, which the company says is growing.

Global consumption of eggs was 170 per person in 2014 and is expected to increase to more than 200 per person by 2021, the company said. Egg packaging was a \$4.2 billion business two years ago and expected to be \$5.35 billion in 2021, Sonoco said.

“Joining our two companies together will enable the best of both companies to be integrated and serve our customers, and will enable Highland to further enhance our speed to service and our ability to offer customers the most diverse consumer packaging formats and solutions in the industry,” said Highland CEO Steve Maxwell in a statement.

Privately held Highland has been owned by Maxwell, John Durham and certain members of the company’s leadership team, Sonoco said. The company has 425 workers. Along with eggs, the company also makes containers for produce, strawberries, blueberries, blackberries, raspberries, tomatoes and grapes. Brands using Highland containers include Dole, Eggland’s Best, Driscoll’s Naturipe and Well Pict.

About 70 percent of the company’s business is in produce and 22 percent in eggs. Highland also has a labels business that accounts for 8 percent of sales.

Sonoco said adding Highland to the company’s portfolio strengthens its presence in the perimeter of grocery stores as more shoppers spend more money there. Perimeter shopping includes fresh and natural foods that often

demand higher prices than packaged goods in the center of stores. Perimeter sales also are outpacing interior store sales and growing.

“Highland’s recognized best-in-class manufacturing and effectiveness in product integration with automated filling machines will add breadth to our growing produce customer mix through a dedicated manufacturing facility located in the important Florida produce market, while also providing us an important entry into egg packaging — a fast-growing protein source in North America,” said Sonoco CEO-elect Rob Tiede in a statement.

Maxwell and Durham have known each other since 1985 when they met in Sinton, Texas, and became friends. Together, the two men purchased Highland Distribution Services Inc. in 2005, then a regional distributor of agricultural packaging products. Maxwell had worked there since 2003.

Sonoco said the deal will be accretive to earnings this year. “The purchase price represents an EBITDA multiple of approximately 6.5 times post-synergies and tax benefits from the write-up of intangibles,” Sonoco said in announcing the deal.

KL Outdoor To Invest \$8.3 Million, Add 100-Plus Jobs in Georgia

by *Plastics News* Report

April 9, 2018, Muskegon, Mich. — Rotational molder and thermoformer KL Outdoor LLC will invest \$8.3 million and create more than 100 jobs at a manufacturing and distribution hub in Stockbridge, Ga.

The expansion follows news of a similar \$9.2 million project in Michigan that was announced last year.

Muskegon-based KL previously operated under the name Ameriform Inc. The company changed its name in 2016 to focus on its key brands.

The company, which makes Sun Dolphin and Future Beach kayaks as well as paddleboards and other sports recreation products, calls itself the world’s largest kayak manufacturer.

New jobs in the Georgia location will be in manufacturing and distribution, according to an April 5 news release from the Georgia Department of Economic Development.

"The company expansion allows KL Outdoor to better serve our key customers by reducing the cost to deliver boats to their stores and ultimately the end-user," KL CEO Chuck Smith said in the release.

In August, the company announced that it was spending \$9.2 million to establish a corporate headquarters in Muskegon and expand manufacturing there, adding 153 jobs.

Plastics News estimates the company's thermoforming sales at \$35 million.

Tekni-Plex Buys Commodore Plastics and Commodore Technology

by *Packaging Business Review*

May 2, 2018 — Tekni-Plex, a US-based provider of packaging materials, medical compounds and precision-crafted medical tubing solutions, has acquired Commodore Plastics and Commodore Technology.

Financial terms of the deal were undisclosed. The acquisition has been made by Tekni-Plex under its newly-formed subsidiary, Dolco, a producer of foam egg carton trays in the US.

Commodore Plastics is engaged in providing wide range of traditional and custom polystyrene (PS) foam trays, including padded food processor, supermarket and industrial trays.

Commodore Technology provides PS foam extrusion systems, dies, thermoformers, trim systems and other molds and equipment to support its sister company's production requirements. The firm also sells its equipment to manufacturers outside North America.

Dolco is engaged in the production of standard and custom PS trays for food processing, fruit and other applications, as well as PET egg cartons and mushroom tills.

Tekni-Plex president and CEO Paul Young said: "Tekni-Plex already has significant tray manufacturing capability via its Dolco business unit.

"The acquisition will allow us to benefit from Commodore's extruder and thermoforming equipment technology, as well as increase our manufacturing footprint. That puts us in a position to provide even more solutions to our customers."

The acquisition follows Tekni-Plex's recent purchase of Dunn Industries, a manufacturer of specialty extrusion tubing for medical device applications.

Dunn offers tight tolerance, small diameter medical device tubing solutions as well as a wide range of thermoplastic materials.

Commenting on the acquisition of Dunn, Young said: "With speed-to-market a critical concern in this market sector, as well as the desire for additional support from suppliers, this acquisition will help make Tekni-Plex an even stronger partner to medical device companies around the world."

Tekni-Plex is engaged in providing packaging materials, medical compounds and precision-crafted medical tubing solutions for medical, pharmaceutical, personal care, household and industrial, and food and beverage industries.

Ground-breaking Ceremony For Modern Production Halls at Kiefel in Freilassing, Germany

KIEFEL GmbH is expanding its production area at the parent company in Freilassing, near the Austrian border in Southern Germany. This continues the physical infrastructure investments of the company belonging to the Brückner Group, Siegsdorf, in 2018. The construction start of the new Kiefel Education Centre was celebrated in February this year. The new training hub prepares Kiefel for future growth, as do the warehouse and pre-assembly areas, which were expanded in 2017. The ground-breaking ceremony for the construction of two new assembly halls took place on April 9th, 2018.

"The two new halls will house state-of-the-art air-conditioned assembly areas for the construction and commissioning of systems for the processing of plastic films covering an area of approximately 2,600 square meters. These halls are designed for maximum flexibility. For example, electricity, compressed air and cooling water are supplied through floor channels at the facilities. In addition, two 12.5 tons hall cranes combined with the height of the halls ensure trouble-free loading and unloading of the machines." emphasizes Helmut Strecha, Head of Production. This expansion will enable the planned growth over the coming years at the Freilassing location.

Thanks to excellent coordination with the town of Freilassing and the experts from the district administration office, the planning and preparation for this construction project progressed rapidly. Completion is scheduled for 2018.

Growth demands more space

Despite the irritations on the world market due to restrictions being discussed, Kiefel anticipates economic growth will continue in the major markets. The order intake of the plastics specialist, which is structured into the four divisions of Kiefel Packaging, Kiefel Automotive, Kiefel Medical and Kiefel Service, remains high. This fact makes a modern production environment as well as additional assembly areas all the more important, because high flexibility combined with short delivery times is an important factor for global competitiveness.

Prent Adding Plant in Mexico

by Stephen Downer, *Plastics News*

May 4, 2018 — Custom medical and electronics packaging thermoformer Prent Corp. is building a 45,000-square-foot advanced manufacturing facility in northwest Mexico, it said May 3.

The facility in Tijuana will be operational in the fourth quarter of 2018, Prent said in a news release. Tijuana is just across the border from San Diego.

The 51-year-old Janesville, Wis., company described the Mexican manufacturing plant, which is its eleventh, as world class. ISO 9001-certified, it will feature a Class 7 clean

room, the company said.

The Tijuana facility will "access Prent's global package design teams, worldwide machine build and custom tool build facilities" to ensure technological consistency, it added.

Prent designs and manufactures its own thermoforming machinery and tools. Its facilities are identical, enabling it to move production and equipment from plant to plant. Prent is the No. 15 North American thermoformers, with estimated sales of \$165 million, according to the most recent *Plastics News* ranking.

The company did not immediately respond to questions about the investment. In a news release, President and CEO Joe Pregont called Mexico "a major North American medical manufacturing hub."

Establishing a presence in Mexico "continues to advance our corporate strategy to locate our manufacturing facilities in close proximity to our customers, reducing both lead time and transportation costs.

"At the same time, it demonstrates our commitment to the preferred source of custom thermoform plastic medical packaging solutions in the world," Pregont said.

Prent, he said, designs and manufactures custom trays, totes, clamshells and automation totes for nearly every major medical OEM in North America, Asia, Europe and the Caribbean. The company was founded in 1967.

"The addition of our 11th manufacturing facility is a key strategic initiative for the company. As we look to the next 50 years, our goal is to continue to innovate, to grow and to evolve to meet the new and emerging needs of the customers we have the privilege of serving today and into the future," Pregont said.

Prent said the new facility will meet the growing demand for medical packaging regionally.

In addition to Janesville, Prent has manufacturing facilities in Flagstaff, Ariz.; Heredia, Costa Rica; Yauco, Puerto Rico; Shanghai; Senai, Malaysia; Holbaek, Denmark; and Singapore.

Coffee Capsules Come with Compostability Credentials

by *Plastics in Packaging*, a Sayers Group Publication

May 17, 2018 — A coffee capsule that combines compostability and oxygen barrier has been launched by European food packaging producer Flo in partnership with NatureWorks.

Called Gea, the capsule is the result of a two-year joint development process between the Italian company and biopolymer producer NatureWorks, which is based in Minnesota, USA.

Erika Simonazzi, marketing director for Flo, said: "Gea represents a new generation of capsules, designed to meet the needs of coffee roasters and coffee lovers, but also to address environmental issues related to the management of waste. As food packaging producers, we are very careful to study the right materials for their use, based on environmental requirements and the dictates of the new rules of the circular economy."

Gea is entirely composed of Ingeo PLA, which is a renewably sourced polymer that is certified for industrial composting systems according to global standards such as EN-13432 (EU) and ASTM D6400-04 (USA). The capsule technology platform is fully approved for food contact and is now in final testing by TÜV Austria and the Italian Composting and Biogas Association.


"A fully compostable capsule provides an elegant and simple system for delivering the valuable used coffee grounds to industrial compost," said Steve Davies, commercial director for NatureWorks Performance Packaging. "The results demonstrate that delivering a superior taste and brewing experience to the consumer does not have to sacrifice sustainability."

Compared to compostable capsules currently on the market, the Gea capsules address market requests for material ageing stability in an industrially compostable format, says NatureWorks.

"Being able to count on a capsule that does not show signs of ageing in a few months, but is shelf stable for years, is a huge value for coffee roasters," explains Erika

Simonazzi. "Roasters should be focused on their coffee, not the packaging it is packed in."

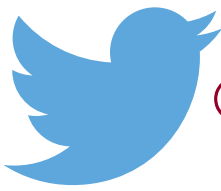
Initially targeting the demanding requirements of high pressure, single serve coffee systems, the Gea capsules will be available on the market starting in October 2018. |

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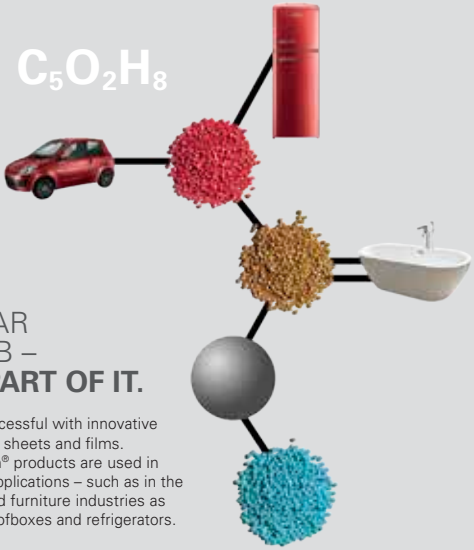
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Interview with Tom Cantwell, General Manager of Tru-Form Plastics, an InterTrade Industries Company

By Conor Carlin, Editor

InterTrade Industries Company is an ISO 9001:2008 custom thermoformer based in Westminster, CA. The company recently combined with Tru-Form Plastics to increase its engineering base and manufacturing capabilities to better serve the medical, automotive and defense industries in Southern California and beyond. Thermoforming Quarterly recently talked to General Manager, Tom Cantwell, about market trends, “West Coast Thermoforming”, and the California perspective on plastics processing.

Carlin: *You’ve been in the plastics industry for about 25 years with experience ranging from food to automotive. What are some of the major changes you’ve seen during this time?*

Cantwell:

One of the primary changes that I have seen is the pendulum swinging from manufacturing primarily being done in the U.S. to much of it moving overseas, and now it is starting to swing back. We all saw the U.S. losing lots of business to Asian markets. This is now turning around and coming back strong, with great potential for North American thermoformer companies keeping business here. We have seen great improvements in technology, which has led to better, more efficient, high-speed equipment, which has had a dramatic impact on bringing the market back. The U.S. market is now competitive with the rest of the world.

In addition, we have seen great improvements in more environmentally friendly practices. As you may know, one of my personal passions is being good stewards of the environment, not only in terms of our company, but also for the industry and plastics as a whole.

Carlin: *Southern California isn’t always recognized as a thermoforming hub, yet people have been heating and forming plastic here since the 1950s. Tell us about the California perspective. Is it different from the Midwest or East Coast?*

Cantwell:

The West Coast market hasn’t been recognized as a

thermoforming hub, but it has been recognized for innovation. Think about Silicon Valley, the bio-hub in San Diego and Orange Counties, and Southern California’s impact on the aerospace and defense industries... the list of innovators goes on. All of these forward thinkers also need partners that are as creative, fast and flexible as they are. That’s where we come in. We can make fast changes, try new methods, and create new tools to meet their needs, then hop in the car and drive a prototype over to their office and collaborate with their team in person, in real time. It makes for an exciting creative process that brings new inventions to the market quickly.

From our California perspective, we’re in close proximity to the medical device companies, so our design engineering team can collaborate face to face with their packaging engineers early in the process to create the most effective device packaging solutions. Some of the aerospace and defense companies are just a few miles away, so when there are design changes or they have other urgent needs, we can resolve issues quickly and hand deliver parts.

Other thermoforming companies have been leery of California due to the labor laws and regulations. Yes, our regulations are sometimes different, but our proximity to our customers saves us both time and money. We can be competitive and save on transportation costs for customers versus the total costs from overseas or Midwest and East Coast suppliers.

Carlin: *You offer both thin- and thick-gauge services to a variety of customers. Talk about why you offer both processes instead of just one.*

Cantwell:

There are a lot of similarities between thin- and thick-gauge thermoforming—the bottom line is that we are heating and shaping plastic. We offer both to serve different markets and for customers that need both processes. InterTrade Industries started producing thick-gauge plastics for aerospace, defense and OEM customers. We initially built relationships with our nearby medical device customers through our acquisitions of thin-gauge thermoforming companies. We see it as an advantage to be able to serve our customers with both large fully assembled thick-gauge

medical device enclosures and thin-gauge medical device packaging products.

Carlin: California is a leader in environmental policy, including several key areas that touch on plastics, such as the recent ruling on recyclability of PETG in the PET stream. How does this affect your business?

Cantwell:

I am a California native and have a true love of the ocean and environment, so, we have always been proactive in recycling and protecting the environment. In 2005, I opened and ran a recycling company. In fact, I even worked with a research team at an international university to develop innovative solutions for recycling plastics.

California is a leader in environmental practices, and we have always followed those policies to help protect the environment. As a California company, these environmental policies allow our businesses to focus on designing more efficient use of plastic, which also has the positive side effect of being more efficient for our customers (i.e., saving them money).

Carlin: What are some of the most interesting areas of opportunity for InterTrade today and why? Where do you see areas of concern?

Cantwell:

As you know, Tru-Form Plastics and InterTrade Industries have joined forces to offer the highest quality thin- and thick-gauge thermoformed products to a wide variety of industries.

With more than a century of combined experience, we are excited to now have the capacity to deliver a host of added benefits to current and prospective customers, including:

- Additional customer service and sales teams to respond to customer needs
- An expanded engineering group to take ideas from concept to completion
- 14 additional machines providing faster production and speed to market
- Increased manufacturing capacity, with more crew members to improve production capabilities and quality
- Assembly of plastic and metal parts into components
- Greater in-house tooling, painting and silk screening capabilities and expertise
- Stronger experienced hands-on management team to oversee projects from concept to delivery

As far as industry concerns, what the administration will do with NAFTA is top of mind. We hope that it continues to be positive for U.S. based companies.

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North America Thermoformed Package Market Analysis

Produced by *Plastics News Research*

[Editor's Note: This executive summary from a new report issued by Plastics News Research is offered as an exclusive benefit to SPE Thermoforming Division members. The editors wish to thank Kelley Trost, Research Director at PN. Thermoforming Division members may purchase the complete 33-page report at a discounted rate by using the following special URL: <http://www.plasticsnews.com/article/20180401/DATA/304019999>]

Current Trends

Thermoformed packaging in 2018 continues to be a robust segment of the North American plastics industry as plastics processors and brand owners seek to meet growing demand for new and innovative packaging products.

Overall, the food and beverage industries represent the largest segment for packaging materials and machinery. Growth in beverage packaging applications is projected at a healthy compound annual growth rate (CAGR) of 4.4 percent to hit \$131.1 billion by 2019, according to analysis by Markets and Markets.

According to a recent study by Freedonia Group, demand in the U.S. for pharmaceutical packaging products is forecast to rise 5.1% yearly through 2021. The study states that parenteral containers will post the fastest growth in primary pharmaceutical packaging, with pre-fillable syringes offering the best gains. Blister packaging and conventional plastic bottles is likely to divide demand for oral pharmaceutical containers.

Ed Dominion, president of D6 Inc., a Portland, Ore.-based thermoformer, said his company is a little counterintuitive to the market. "We are seeing a mass exodus away from tamper evidence," he said. "People want true tamper evidence where there is a seal or something that is broken, making it apparent. We are seeing a move toward top seal." Mergers and acquisitions also continue to be a theme in the North American plastics and packaging segments. John Hart, managing director of P&M Corporate Finance LLC of Southfield, Mich., noted that despite lower overall volume trends for global M&A in 2017, "the plastics and packaging segment remained highly active this year."

Technology/Internet of Things

Technology also is a key trend among thermoformers in 2018 and that will continue to be a factor going forward. D6 is pioneering math and the use of algorithms to identify sales trends and determine which packaging options are most likely to be in demand in today's market. Dominion said his company has been using algorithms with customers and it has proven to be incredibly accurate. "We also have used algorithms to predict the production of parts," he said. "It is math based and we are also dealing with metadata. We can create predictable events."

While the IoT trend is in its infancy, Jeff Mengel, partner at Plante Moran PLLC, noted that over the next decade "if you are not on the bandwagon, you are going to be left behind." "The Internet of Things is starting to mature. It isn't just thinktanks doing it," he added. "Companies have figured out how to integrate activities in the manufacturing space and it is significantly reducing labor." And labor is a large expense, at about 25 percent for most thermoformers. If labor is 25 percent and it is going up and the cost is one that can't be passed through, it can have a detrimental effect on a company's bottom line. It is an issue that companies must address. Dominion said labor issues ultimately impact the bottom line, but solutions shouldn't always be made with the bottom line in mind. "If you pay more, you get better people," he said. "There are people out there willing to work. You have to give people good opportunities." Once you attract good workers, it is imperative to offer effective training.

Growth Drivers

In 2018, increasing demand from food, medical and pharmaceutical end markets continue to drive growth in thermoformed packaging. Thermoformed packaging processors are wrestling with key issues as they pursue growth. This includes the rising cost of raw materials, the ever-changing face of e-commerce, and various profitability pressures. As a result, competitiveness can prove to be a key growth driver among thermoformers serving the packaging segment. This includes doing things cheaper and faster.

Recyclable Packaging

Another facet of thermoformed packaging is the opportunity it presents to develop creative new packaging

options that will result in pulling materials from recycling streams.

Toymaker Hasbro is taking a proactive approach, announcing recently that it will start to use plant-based bio-PET for blister packs and plastic windows in its product packaging starting in 2019. According to Hasbro, the use of bio-PET plastic is a step in its sustainable packaging journey. In 2010, the company eliminated wire ties and, in 2013, replaced polyvinyl chloride with PET. In 2015, Hasbro achieved 90 percent-recycled or sustainably-sourced paper for packaging and in-box content and moved from PET to rPET in 2016. Moving forward, Hasbro will use bio-PET plastic made with 30% plant-based material derived from agricultural byproducts. Says Hasbro, this shift in material builds upon its efforts to continuously enhance the sustainability of its packaging and enables the company to develop packaging that is less reliant on nonrenewable resources.

Machinery and Technology

Thermoformers today produce packaging on the latest thermoforming machines and can use vacuum forming, pressure forming, twin sheet forming as well as custom thermoforming applications. Jeff Mengel has been involved in the packaging segment for more than two decades and noted that he has seen plenty of innovation in thermoforming machines. "There has been a lot of change to the main machine," he said. "The main changes have been in the footprint, the heat requirements and the utility requirements. We are seeing utility consumption being a bigger point in the purchasing decision."

D6's Dominion noted that the thermoformed packaging segment continues to see advancements and innovations in robotics. "A key is how fast and stable the automation can operate," he said. Additionally, Dominion said he continues to see machinery advances particularly by European manufacturers. "We are seeing advances in thermoforming, especially overseas," he said. "In Europe, they are doing it right. It is more compact with higher speeds and advanced cooling systems. We are seeing this among the leading manufacturers."

"The equity groups keep buying," Dominion said. "Sometimes, they can't get the equipment, so it is cheaper to buy a company with the equipment you need."

SPE Salary Survey 2018

Plastics Industry Salaries Tick Up, As Finding Enough Skilled Workers Continues to Challenge Employers

by Robert Grace

Demand for qualified plastics industry workers remains strong, job satisfaction remains fairly high, and compensation trends have turned northward again after three consecutive years of modest declines, according to the recently completed 2018 Plastics Salary Survey.

SPE and MBS Advisors conducted the annual online survey in February and March 2018. This year's survey results are based on analysis of 1,998 responses by Brand Beacon Consulting of Franklin, Tenn., from among a random sample of plastics professionals, 17 percent of whom were from outside the United States. The response rate was sharply higher than the 1,351 who responded to the study a year ago, and the largest in the survey's 15-year history.

Base salary and total cash compensation improved in the 2018 survey, reversing a three-year slide. For this year's respondent, the average base salary increased by 4.3 percent and average total compensation grew by just over 6 percent. Those numbers marked the second-highest increases reported for base and total compensation in the past decade – second only to 2014.

The survey asked managers to select from a list their most difficult hiring challenges. The results should prove comforting to skilled graduates entering the marketplace.

Strong demand for skilled workers

"Finding qualified candidates" continues to stand out in bold relief, with 86 percent of managers citing this as their most difficult challenge for 2018, up significantly from the 71 percent in last year's survey. In these people's minds, nothing else comes close. "Meeting compensation expectations" ranks a very distant second (35 percent), but increased significantly. "Difficulty in enticing candidates to relocate" also rose sharply, to 18 percent from 5 percent a year ago.

"Companies are having to pay a bit more to attract the talent they've been looking for," said Dennis Gros, president of the Recruiting Division of MBS Advisors. Given the competitive marketplace, it has never been more

The Business of Thermoforming

important for companies to convey a credible message about why they are a good place to work, said Gros, whose Franklin, Tenn.-based firm, Gros Executive Recruiters, launched this survey in 2004. (Molding Business Services of Florence, Mass., acquired Gros Executive Recruiters this past January, and is just now rolling out the newly named entity of MBS Advisors.)

The outlook for employee growth remains reasonably strong as more than half (55 percent) of managers continue to expect their full-time headcount to increase in 2018. Some 36 percent expect staffing levels to remain steady, while only 7 percent anticipate a decrease. These trends have remained relatively flat over time, with no significant changes looking back to 2013.

Optimism on the pay front

Current industry managers are expressing optimism for being able to deliver higher raises to some employees in the coming year. The percentage expecting compensation to grow by 4-6 percent increased significantly in this year's survey, up to 19 percent, making it the highest that number has been in recent survey periods. Some 58 percent of managers say their employees' compensation will increase by a modest 1-3 percent in 2018, while 17 percent anticipate no change.

Managers actually are more optimistic than employees in general when it comes to assessing pay prospects for the coming year. Some 23 percent of employees expect no change in their compensation in the coming year, and just over half (52 percent) expect their base salary to creep up by just 1-3% this year.

Speaking of money, 69 percent of respondents said they received a raise in the past 12 months, which is statistically comparable to the 71 percent who reported the same in 2017. Well over half (62 percent) received a raise of 1-3 percent – by far the most prevalent range reported. A third reported a raise of more than 3 percent. Very few received a raise of less than 1 percent or more than 10 percent.

In terms of additional forms of compensation (bonuses, incentives or commissions), more than half of respondents (57 percent) expect their bonuses or other incentives to hold steady for 2018, with no change, while 7 percent anticipate a decrease. Comparable to last year, some 12

percent expect an increase greater than 6 percent in such compensation.

"I see 2018 as the 'Year of the Raise,'" predicts Gros. "It may surprise some people, on the positive side." He added that he believes "all manufacturing is poised to make a healthy leap forward."

Who gets paid the most?

Not surprisingly, C-level and executive management types (based on 225 replies) commanded the highest average annual compensation among respondents, at \$188,195. Sales and marketing officials (430 replies) were next, at \$140,414. Product development professionals (294 replies) reported average annual compensation of \$113,982; supply-chain employees (just 32 replies) clocked in at \$109,937; and engineers of all types (573 replies) averaged bringing home just under six figures, at \$98,924.

It's worth noting that survey respondents skewed to the older end of the spectrum (which would account for some higher salary averages). Nearly half (932 respondents, or 49.1 percent) reported having 20 years or more of experience, while 327, or 17.2 percent, have five or fewer years of experience.

How are women faring?

As for the gender split, 10.9 percent of the respondents (218) were women, and nearly half (48 percent) of the females who replied said they earn \$100,000 or more (vs. 55 percent of the males).

Generally speaking, it seems fair to say that the level of job satisfaction within the industry is relatively high. Combining responses from the top two choices on the survey – "very" or "somewhat satisfied" – the percentage happy with their current position ranged from 68 percent in the 35- to 44-year-old age group, to 85 percent aged 65 or over. Some 10-15 percent reported being "somewhat" or "very dissatisfied" with their current jobs.

Looking at who responded

As for the respondent profile, nearly a third (32.8 percent) are primarily involved in injection molding; next is resin, compounding and additives (16.8 percent), followed by pipe/profile extrusion (4.2 percent), blown or cast film (3.4 percent), thermoformed packaging (3.2 percent), and

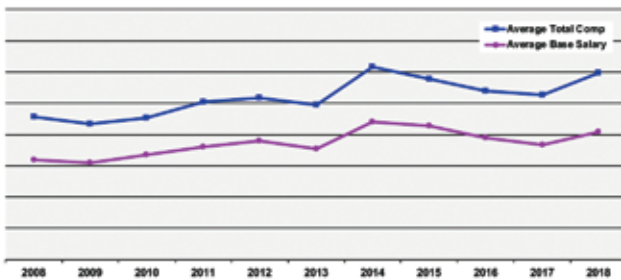
SAMPLE SALARY REPORT



AVERAGE BASE & TOTAL COMP REPORTED SALARY BY YEAR OF SURVEY

2008 - 2018

The graph below depicts the base salary and total compensation trends. Both base salary and total compensation improved in 2018.



Salary figures above are based to respondents who were employed in the plastics industry at the time of each survey.

Year to year comparisons vary based on random participation of different individuals each year.

sheet extrusion (3.1 percent).

"This year's SPE salary survey reminds us that plastics is a great business for a lot of people," said SPE Chief Executive Officer Patrick Farrey. "Job prospects remain strong, salaries are increasing, and job satisfaction remains high. "Our biggest challenge is how to encourage more young people to consider a career in plastics. SPE remains committed to future workforce development through our middle and high school Plastivan programs and our numerous plastics industry Foundation scholarships."

For more information about the study, or to get the full report, please visit 4spe.org/salariesurvey18. |



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SAMPLE SALARY REPORT



AVERAGE BONUS / COMMISSION / INCENTIVE BY YEAR OF SURVEY

2008 - 2018

The graph below depicts the average bonus / incentive / commission by year for 2008 - 2018. As this shows, performance-based compensation improved strongly in 2018 - an increase of 16.4% since last year.



Salary figures above are based to respondents who were employed in the plastics industry at the time of each survey.

Year to year comparisons vary based on random participation of different individuals each year.



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Multilayer EVOH/HDPE Packaging in Processing and Performance of Recycled HDPE

By Didier Houssier, Geert Herremans, Kuraray, EVAL Europe N.V. and Edward Kosior, Dr. Jon Mitchell, Kelvin Davies, Nextek Ltd.

This paper was original presented at ANTEC 2017

Abstract

Kuraray, EVAL Europe N.V. (EE) produces Ethylene Vinyl Alcohol copolymers (EVAL™), which are used in multilayer structures in a combination with a wide range of materials such as High Density Polyethylene (HDPE) to produce multilayer bottles to provide superior barrier properties to gases, flavours or bring functional barriers against external contaminants such as mineral oils (MOSH, MOAH). Bottles are typically made by Co-Extrusion blow moulding (Co-EBM) technology and are used for beverage packaging such as dairy products and specialty milk and other packaging applications for sauces or dressings or for the packaging of medical products for which the Water Barrier of HDPE is of added value. The objective of the study was to investigate if multilayer EVOH/HDPE rigid packaging material, which is a percentage of the post-consumer recycling stream, can be effectively sorted with the HDPE stream and decontaminated back to food grade approved for use as Post-Consumer Recycled (PCR)-HDPE into food packaging applications.

Multilayer rigid food packaging found in the postconsumer recycling stream has been represented in the design of materials guides and recycling guides as 'may be suitable' for recycling. The present work investigates the recyclability of EVOH barrier packaging due to the growing trends of multilayer rigid food packaging and more importantly, as recovery systems strive towards a better circular economy.

The steps taken to produce food grade rHDPE with analysis included; Audits of the HDPE fraction at Viridor MRF, testing on automated NIR sorting equipment at Tomra (Titech), compounding in a low pressure, elevated temperature, food-grade decontamination process and overall migration testing conducted by Smithers-Pira.

The evaluation showed that post-consumer HDPE (rHDPE) material containing at least 0.25% EVOH (equivalent to

5% multilayer EVOH/HDPE packaging) can be "super cleaned" to food grade quality without any significant impact on the process performance or physical properties compared to rHDPE only. The results showed that at the levels of multilayer EVOH packaging typically found in the recycled HDPE stream, the rHDPE can be processed and utilized in a full range of applications, without impact on migration characteristics or physical properties compared to rHDPE alone.

Introduction

Food packaging has seen significant changes over recent decades with demand for pre-packaged food increasing, hence the requirement for research and development in barrier and shelf life extending materials. Demand for food packaging resin is also increasing with HDPE behind PET but above PP and PS. ^{[1][2]}

Packaging must comply with food safety regulations to protect the consumer, therefore multilayer structures are essential in preserving and protecting the food. In certain cases, packaging provides a barrier to gas permeation because of the risk of microbial activity and food spoilage, in other cases, functional barrier helps keeping the food away from external contaminants. In Europe, the Plastics Regulation (EU) No 10/2011 defines layer B as a "functional barrier" if it reduces the level of migration of a substance from layer A to layer C to a level where it can meet regulatory limits. Section VII from the Food and Drug Administration (FDA) 'Guidance for Industry: Use of Recycled Plastics in Food Packaging: Chemistry Considerations,' defines the use of an effective barrier. ^{[1][3]}

Kuraray is a world leader in EVOH (ethylene vinyl-alcohol copolymers) production and technology. An EVAL™ layer thickness of only a few microns helps avoid spoilage by keeping oxygen and odours out, while locking flavours, aromas and modified atmosphere inside the package. This prolongs shelf life reducing the need for artificial additives to be added into food. Fewer resources can often be used for the same packaging function. Optimized portion size, light weight and extended freshness help improve the efficiency of storage, transport and display, saving costs and preserving resources. Kuraray quote that "1 mm of EVAL™ provides about the same gas barrier

properties as a 10 metres thickness of LDPE.” [4]

EVOH will continue to be used in packaging for these reasons and ideally would be recycled with minimal detrimental effects in the polyolefin industry. It is well known that EVOH offers great barrier protection against oxygen, odours and gases however EVOH has also been reported to absorb significant amounts of moisture in humid conditions which is why multilayer structures are needed.^{[5][6]}

Kuraray, EVAL Europe N.V. produces Ethylene Vinyl Alcohol copolymer (EVOH) which is used in blow moulded HDPE multilayer bottles to provide gas barrier properties for juice or specialised milk products. Food grade recycled HDPE (rHDPE) is produced in UK and other countries, primarily from clear (natural) coloured monolayer blow moulded white (fresh) milk bottles and is used back into the manufacture of new milk bottles at approximately 15%, providing closed loop recycling of this material in the UK. The food grade rHDPE is a commercial material currently only available from a few suppliers, but it will be available from an additional number of recyclers in the UK and other countries in the near future.

For PP, the recyclability characterization in the WRAP guidance states that EVOH if less than 10% of total pack weight is ‘not ideal’ (Category B) and if above 10% pack weight then it is classed as ‘detrimental’ (Category C). For HDPE milk bottle recyclability, co-extruded EVOH barriers are within category C. Category B recommends coextruded tie-layer functional polyolefins if less than 3% total bottle weight. These constraints could have better definitions to enable manufacturers of EVOH to participate in the circular economy with growing pressures on recycling.^{[7][8]}

Kuraray, EVAL Europe N.V. wanted to investigate in detail that multilayer natural coloured HDPE/EVOH material can be effectively recycled as a percentage of the post-consumer stream and used back into food packaging and applications. Nextek assisted with conducting this study and trials and evaluation of the recycling process with blow moulded multilayer HDPE barrier bottles. Food grade rHDPE recycling involves sorting that removes colored HDPE, although some white is often retained. The performance of EVOH was also assessed during the food grade decontamination or super cleaning stage to confirm that the presence of EVOH does not negatively impact on

the process or the properties of the final food grade material.

Market applications and percentage of EVOH in recycling streams

An assessment was made based on available market data and material audits to establish a typical and maximum percentage of HDPE barrier packaging in the market. Market data based on the tons of sales of HDPE and EVOH into the packaging market is very limited making accurate calculation difficult. The material audit could only be conducted on a relatively small sample and this provides only a snapshot of the composition of the recycled HDPE stream.

Volumes and applications of EVOH in the market

It is difficult to acquire quantitative data on the volume of rigid multilayer HDPE packaging in the UK market. The segment is relatively small and so is not usually differentiated in any way, and is included in much broader and larger volume categories for rigid HDPE.

Using data from “Plastic Packaging Composition 2011” Wrap report, 498,000 tons (29%) of the UK consumer packaging market are bottles, and 158,000 tons (32%) of bottles are HDPE, which appears to have remained flat in recent years. The large majority of this volume estimated at 119,000 tons is for monolayer natural HDPE packaging used for white milk, fresh juice products, yoghurt and other refrigerated short shelf life goods. Household chemical and personal care represented another category for colored HDPE bottles.^[9]

The Wrap report indicates the volume of consumer packaging HDPE bottles in the “on-the go” category is zero (0 tons), further indicating the relatively small size of this market. Consideration should be given to the fact that in the UK a lot of packaging that is disposed of away from home, (on-the-go) is not recycled. In addition, many of the multilayer HDPE bottles have full sleeve labels, which can result in misidentification during NIR sorting, directing the bottles away from the HDPE fraction.^[9]

In the European market, rigid packaging utilizes approximately 30% or 8,500 tons of EVOH. Based on a 5% by weight composition of EVOH, this represents 170,000 tons of multilayer EVOH rigid packaging. HDPE bottles made by extrusion blow molding estimated to be 30-35% of the market, based on an average 5% barrier level, this

equates to 59,500 tons of HDPE multilayer rigid packaging in Europe.^[9]

Further differentiation in the UK market is difficult, research does not identify or distinguish barrier HDPE as a separate category. Recovery rates of 0.42% from the audit, applied to the 158,000 tons of HDPE bottles equals to 664 tons of multilayer HDPE bottles in the UK per year. This calculation may underestimate this market volume but it is clear that the volume is relatively small as part of the overall HDPE bottle packaging market.^[9]

Experimental

An addition rate of 10% multilayer post-industrial materials collected from various European converters with a nominal structure of HDPE//EVOH(5%)//HDPE was selected to represent a maximum peak percentage of multilayer material that might be found in the recycle stream. At these addition rates, with a HDPE//EVOH(5%)//HDPE structure, the actual EVOH content was 0.5% in the melt blend.

Biffa polymers supplied food grade rHDPE material for the melt blending trials; two compounds were prepared at Brunel University. One compound used the food grade rHDPE and a second compound using virgin HDPE, both with 10% HDPE:EVOH. Both compounds were decontaminated at Starlinger, then at W. Muller in Germany each compound was dry blended at a 1:1 ratio with virgin HDPE and extruded into a number of bottle structures. For migration studies PIRA recommended testing using simulant D1 (50% Ethanol) at 40°C for 10 days, in accordance with EU regulation No 10/2011, testing was done in triplicate. For physical testing at ipolytech the materials were injection molded into test specimens according to ISO527-2, which were used for tensile testing; central parts of the specimens were used for Izod impact testing, and end parts were used for density determinations.

Results

Automated sorting trials

Kuraray provided 26 samples of a range of multilayer EVOH/HDPE bottles, from food & beverage, pet food and household chemical applications, with the layer of EVOH ranging from 3.8-14.5%. The bottles were sent to Tomra (Titech) to establish if their NIR detection system was able to detect the presence of EVOH or any other variation that would distinguish them from monolayer HDPE articles.

Tomra assessed the containers including labels, which can influence identification. In all but one case, the bottles were detected as HDPE, which would conventionally be sorted to a HDPE fraction in most MRFs. Sample 13 the “Veet” cosmetic bottle was identified as PP. Tomra indicated by using a modified database, six of the twenty-six bottles could be separated from “standard” HDPE. However, this would likely result in an increased number of non-barrier HDPE bottles also being identified as multilayer, and with databases designed to identify HDPE film, some multilayer bottles may be sorted to the film fraction. It should also be noted that as with other packaging, unless the full body sleeve labels are removed prior to sorting, bottles are often miss-identified and sorted according to the label material, such as PET, LDPE, etc.

These results confirm that multilayer EVOH/HDPE bottles would most typically be identified as HDPE and be sorted by NIR based automatic sorting systems, which are used in MRFs and PRFs around the world, into the HDPE stream with monolayer HDPE packaging containers. Typically, the HDPE packaging materials are further sorted based on color to isolate the higher value natural HDPE fraction. All the multilayer HDPE bottles were colored and so would be sorted in the colored “jazz” fraction.

Manual sorting bale audit at Viridor Arundel

A manual audit of the HDPE fraction at Viridor recycling facility in Arundel UK took place to determine the level of multilayer HDPE packaging that could be identified. A bale of material that had been identified by NIR sorting as HDPE was hand sorted, first selecting colored HDPE and then visually looking for articles that may be multilayer EVOH/HDPE, based on their labelling and the product type.

The following materials types were identified:

- Dairy based nutritional supplements.
- Dairy based drinkable “on the go” breakfast products.
- Dairy based high protein drink product.

A number of other dairy products, for consumption by humans and pets, personal care and household chemical and health supplements packaging was confirmed to have non-barrier structures.

From the colored HDPE fraction, there were fifty-five (55) items that appeared to be potential multilayer structures, based on the application indicated by the label. These

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were sent to EVAL Europe N.V. laboratory for cross-section analysis, who determined that 8 of the 55 samples were indeed multilayer.



Figure 1: Coloured HDPE packaging found in the postconsumer recycling stream

Table 1: Composition of HDPE bale from Viridor Arundel MRF.

Fraction	Weight (kg)	Percentage (%)	Items
Natural	384	80	
Coloured	6	20	
Resort Coloured			
Possible Multilayer	14	2.9	55
Confirmed Multilayer			
EVOH	2	0.42	8

Long life dairy-based products such as drinkable yoghurt, “breakfast on the go” and health products were the majority of the multilayer barrier bottles. From this small sample from the recycled HDPE stream, it was determined that approximately 20% was colored and 0.42% was EVOH multilayer. As expected the majority of the sample (80%) of the HDPE fraction was monolayer, natural color fresh milk and juice packaging.

Typically, the HDPE materials are further sorted to extract the colored materials. Based on this audit if the multilayer

was all sorted to the colored fraction, it would be 2% of the colored “jazz” fraction.

Compounding Trials

Post-consumer recycled HDPE (rHDPE) that had been decontaminated and processed to pellets suitable for food grade was obtained from Biffa Polymers and 45kg was dry mixed with 5kg of granulated post-industrial bottles from multilayer extrusion blow molding using a high-speed mixer (Blend A.50). Similarly, 45kg of virgin HDPE (vHDPE) from Sabic was dry mixed with 5kg of granulate (Blend B.50). The two blends were then separately melt compounded on a twin-screw extruder to produce two batches of pellet, both containing approximately 0.5% EVOH.

The compounding trial was conducted by Nextek at Brunel University, and attended by Kuraray. Blend A.50 had a green/grey color, consistent with using recycled HDPE; Blend B.50 was natural white, consistent with virgin HDPE.

Compounding of the dry blend was conducted on a 30mm co-rotating twin screw extruder at 210°C with an average residence time of less than 3 minutes, to produce a pelletised material.

Decontamination of the blended material

The pelletised HDPE blends were sent to Starlinger for decontamination on a pilot scale Viscotec unit in the Starlinger laboratory. Both blends were processed under high vacuum for 2 hours at 125°C to remove volatiles. This ensures that the 0.5% EVOH blended materials experience the same thermal process typically used for monolayer rHDPE to provide a material suitable for food grade applications.

The thermally processed Blend A.50 (rHDPE) and Blend B.50 (vHDPE) material were then sent to Germany for extrusion (Co-extrusion) blow molding trials to produce monolayer and multilayer bottles.

(Co-)Extrusion Blow Molding (Co-EBM) Trial

The EVOH/HDPE blends were made into a number of bottle structures at W. Muller facilities in Germany. Bottles from selected trials were subsequently used by Pira for migration studies to compare the performance of the EVOH/rHDPE blend with EVOH/vHDPE materials.

A range of bottle structures were made with Blend A.25 and Blend B.25 compounds, both of which were obtained from Blend A.50 and Blend B.50, dry mixed with virgin HDPE 1:1 prior to extrusion, to have a final EVOH concentration of 0.25%. Different bottle structures and trial conditions are summarized in Table 2, the order of which was modified from the original trial plan, to optimise the sequence of material changes. Extruder and machine settings were set to standard conditions, to produce the 350 ml ketchup bottle.

Table 2: Trial bottle structures made with rHDPE, vHDPE and 0.25% EVOH blend.

Trial #	Layer Outside	Layer 2	Layer 3	Layer 4	Layer 5	Layer 6 Inside
1	vHDPE	vHDPE	Blend B.25	Blend B.25	Blend B.25	vHDPE
2	vHDPE	vHDPE	Blend A.25	Blend A.25	Blend A.25	vHDPE
3	Blend A.25	Blend A.25	Blend A.25	Blend A.25	Blend A.25	Blend A.25
4	Blend B.25	Blend B.25	Blend B.25	Blend B.25	Blend B.25	Blend B.25
5	Blend B.25	Blend B.25	Blend Tie	Blend EVOH	Blend —	Blend —
6	Blend A.25	Blend A.25	Blend Tie	Blend EVOH	Blend —	Blend —
7	vHDPE	vHDPE	Blend Tie	Blend EVOH	Blend —	Blend —
8	vHDPE	Blend B.25	Blend Tie	Blend EVOH	Blend Tie	Blend vHDPE
9	vHDPE (white)	Blend A.25	Blend Tie	Blend EVOH	Blend Tie	Blend vHDPE

Virgin HDPE used was Sabic™ 5823, Tie layer was Admer™ NF0408E and EVOH was EVAL™ F101B, in addition to Blend A.50 and Blend B.50, which were dry mixed with the Sabic 5823 at 1:1 to give a final EVOH concentration of 0.25% in Blend A.25 and Blend B.25, used to produce the bottles.

Standard process conditions were used during the trial for Blend A.25, Blend B.25 and vHDPE materials. Good quality bottles were formed using all the materials and structure variations.



Figure 4: Blend A dry mixed 1:1 with vHDPE (LHS) Bottles produced from trial #3 (RHS)

In trial #9 a white masterbatch was added to the external virgin HDPE layer only. The added pigments were able to mask the grey/green coloration of the rHDPE material that was used external to the EVOH layer. For color control and quality purposes, it is likely that recycled materials would be used in a similar structure to that used in trial #9, a multilayer structure that is also commonly used when incorporating in-house regrind and uses the EVOH as a functional barrier.

Migration Testing

Bottles from trials #2, #3, #4 and #9 were sent to PIRA to conduct overall migrations studies. The test was carried out by filling the bottles with the simulant and the average migration level of three samples tested is reported. In all test samples, the overall migration was well below the specified limit of 10.0mg/dm³.

Table 3: Overall migration testing results, specified limit is 10.0mg/dm³

Trial Sample Overall	#2	#3	#4	#9
Migration (mg/dm ³)	0.0	0.5	0.1	0.3

Migration results show that under these test conditions, neither the rHDPE Blend A.25 nor the vHDPE Blend B.25 materials had high levels of migration. These results indicate that the presence of 0.25% EVOH in the recycled HDPE material does not contribute to overall migration. In addition, when used external to EVOH barrier layer, or external to a virgin HDPE layer or as a monolayer structure that is in direct contact with the product, migration levels are well below maximum allowable limits.

Physical Testing

Samples of the dry mixed Blend A.25 and Blend B.25 prepared at W. Muller for extrusion blow molding were sent to the independent testing facility ipolytech for evaluation of physical properties.

Table 4: Physical test results on HDPE:EVOH blends using in moulding trials.

Test	HDPE (Ref)	rHDPE	Blend A.25	Blend B.25	Method
Density (g/cm ³)	0.956	0.956	0.956	0.954	ISO1183
Izod Impact (kJ/m ²)	31.2	29.1	39.1	42.8	ISO 180:2000
EModulus (Mpa)	1245	1324	1280.3	1306.5	ISO527-2:2012
Strain at Break (%)	407	427	263.7	228.7	ISO527-2:2012
Yield Stress (MPa)	23.5	23.2	23.2	23.5	ISO527-2:2012
Yield Strain (MPa)	10.2	10.4	10.6	10.1	ISO527-2:2012

Results show only small variations in properties of the rHDPE and vHDPE blended compounds, consistent with a slight reduction in performance typically observed between recycled and virgin HDPE materials.

Conclusions

These results indicate that there are no reasons that multilayer HDPE/EVOH structures could not be included in the recycling of HDPE packaging and that levels as high as 5% will have no significant impact on properties or performance of the recycled HDPE resins.

Trial results show that at levels of 0.25% EVOH in recycled HDPE and virgin HDPE, the extrusion blow molding processing performance, overall migration for direct food contact and physical properties were all unaffected, compared to rHDPE alone.

An audit of a bale of post-consumer HDPE bottles identified that only 0.42% was multilayer, the percentage increases to 2% multilayer of the colored HDPE fraction, into which most multilayer bottles would be sorted.

Commercially only natural rHDPE is recycled back to food grade, and used primarily in the manufacture of new natural milk bottles. It is most likely that the current formats of multilayer bottles would be sorted into the colored fraction, which is not currently processed to food grade material. At measured levels of approximately 2%, the multilayer bottles would have no impact on the reprocessing of these colored materials.

The multilayer EVOH bottle format is not specified in recycling surveys and published data. One Wrap survey indicated that there was no discernible quantity of HDPE recovered in the "on-the-go" bottle packaging market segment. However, products designed for out of home consumption such as drinkable yoghurt and breakfast products were the most common multilayer bottles found in the audit. It should be noted that in the UK, most public bins are not sorted or recycled, so packaging disposed of "away from home" and kerbside collection systems, is unlikely to be recovered for recycling.

The compounding and blow molding trial utilized natural rHDPE, so that any effects from the presence of the postindustrial HDPE/EVOH blended material could be more easily seen if it occurred. In practice, multilayer HDPE bottles are all colored and would most often be sorted into the colored (jazz) fraction. Some MRFs leave white HDPE containers in the natural HDPE fraction to boost yields, and at low levels, this has a minimal impact on color or quality of the natural rHDPE.

Tomra trials confirmed that bottles would be sorted as HDPE, or according to the label material, which can happen with bottles that have full body sleeves. Some multilayer products may be able to be differentiated by NIR sorting if a modified database was used.

The test material with 0.25% EVOH was converted to bottles under standard conditions, indicating processing characteristics were unaffected. A few black specks were identified; however, these were not considered inherent to the test material and on occasion even appeared to be present in the virgin HDPE layer, indicating they may be from the bottle making process.

Overall migration testing showed very low migration levels below 0.5mg/dm³ for all structures, including 100% monolayer blend material in direct contact with the

simulant, compared to the specified limit of 10mg/dm³. With this low overall migration result, no discernible difference could be seen with different bottle structures. With a virgin HDPE inner layer or with an EVOH functional layer between the blend material and the simulant, migration results were not reduced further.

Other than a slight reduction of physical properties that would be expected between virgin and recycled HDPE, testing showed good tensile and impact strength.

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European Thermoforming Conference March 14-16, 2018 Rome, Italy

Venimus, Vidimus, Didicimus*

An international crowd learned about advances in thermoforming technology, materials, and new ideas for the circular economy

By Conor Carlin, Editor

*[Editor's Note: this article has been adapted from the original which appears in *Plastics Engineering* (Wiley), May 2018 issue]*

Over 240 attendees from more than 20 countries arrived in Rome this May for the 11th European Thermoforming Conference hosted by the SPE European Thermoforming Division (ETD). Major themes included the application of Industry 4.0 to thermoforming processes and circular economy initiatives in Europe. Antonio Staffoni, CEO of Polytype/OMV, welcomed delegates and Dr. Raed Al-Zubi, SPE President, congratulated the ETD board on another successful conference during the gala dinner.

Industry 4.0 for Thermoforming?

Ruggero Frezza of M31 (Padova, Italy), a boutique technology investment and IP firm, opened the proceedings by presenting an intellectual framework for how Industry 4.0 has evolved. Data acquisition, analysis, and sharing are the foundations for what is sometimes termed “the 4th industrial revolution”. Frezza explained that understanding 4.0 isn’t limited to the technological components, but rather that it has the potential to revolutionize manufacturing in different ways. He offered a parallel between the crowd-sourced GPS app, Waze, and how machines can be used as part of a smarter ecosystem. Sharing data leads to faster optimization, better collective intelligence and emerging behaviors. Examples in the plastics industry include new RF heating technology with better closed loop control that leads to more uniform heating distribution, a critical element for repeatability in thermoforming. Going further, machines with their own “dynamic fingerprint” can potentially raise warnings about abnormal behavior via properly located sensors to monitor processes.

In thermoforming, however, many of the software-related advances are limited to the machines themselves and are driven by advances in servo and sensor technologies, not necessarily from the application of M2M communications that are found in the smart factories of larger companies where IoT, digital supply networks and interoperability are gaining traction. Hubert Kittelmann of Marbach Tool (Heilbronn, Germany) explained how ToolVision (Zusmarshausen, Germany) is one example of a system that measures and monitors more elements than just machinery-based HMI. Sensors and gauges are added to the ovens and presses to measure motion, pressure, strain rates, sheet temperature and tool temperature. The incoming data is fed into a CPU and displayed in near-real time on a separate graphical user interface (GUI). The output data allows operators to fine-tune the process and identify areas for efficiencies. Founded in 2008, ToolVision reports a steady increase in business which reflects a desire for more data among thermoformers.

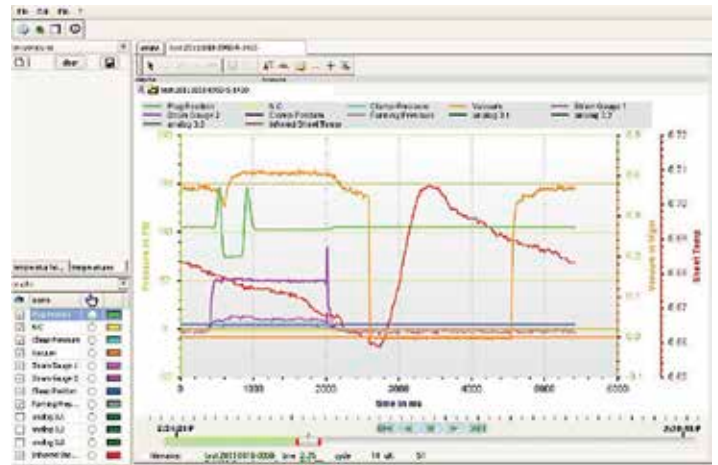
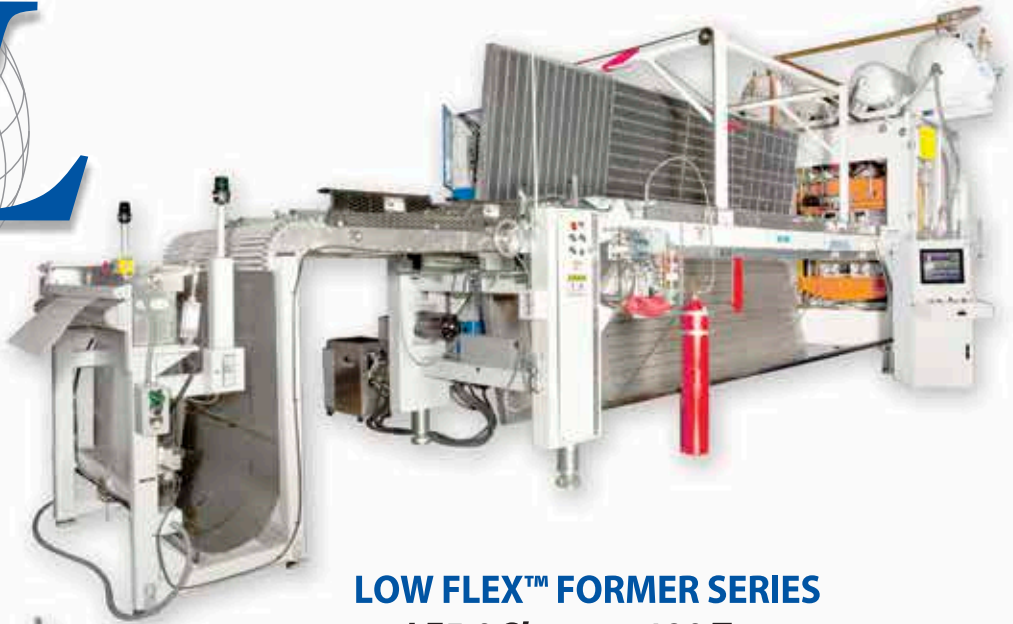


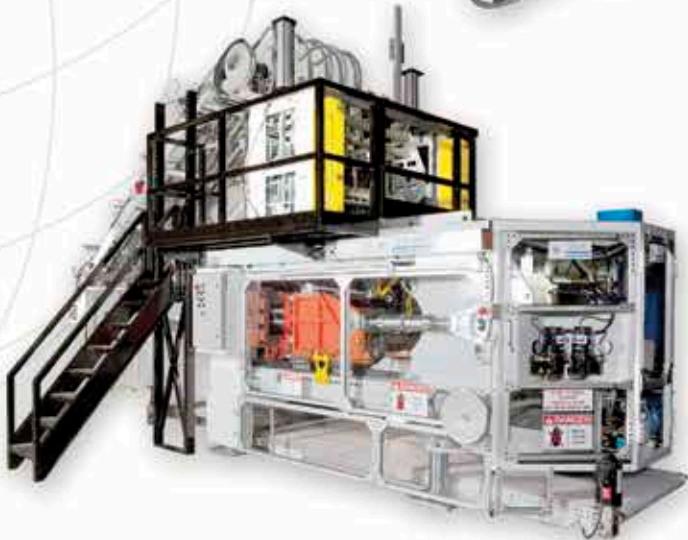
Image 1: Screen shot of real-time data visualization of ToolVision system (source: uVu Technologies)

New business models are also emerging thanks to innovative thinking stemming from 4.0. “Servitization” is a neologism designed to capture the strategy of supplying more than just equipment, providing a service instead of a product. Customers are becoming more reliant on the specialized knowledge that resides inside the manufacturer of highly complex equipment. Some companies, notably Rolls Royce, are creating new offerings whereby customers pay for the amount of time they use a product, such as an aircraft engine. The model is loosely based on the ‘evergreen lease’ concept pioneered by Interface carpet in the early 2000s. Instead of selling carpet to customers, the company leased the use of the carpet, replacing or



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repairing only those sections that were worn or damaged. Interface explicitly created their model to address the amount of carpet going to landfill. In plastics, Frezza highlighted The Plastics Bank, a movement that aims to servitize disposable plastic through Social Plastic™ whereby waste plastic is transformed to currency. The foundational goal is to incentivize the safe and proper collection of plastic waste to avoid marine pollution by paying above-market rates in impoverished areas of the globe.

Know How vs. Know Why

Dr. Amit Dharia of Transmit Technology Group (Sterling, TX) delivered a thought-provoking paper on the application of a new type of test method for thermoforming. Framed as “know how vs. know why”, Dr. Dharia suggested that many thermoforming processors know how to manage their current process, but they do not necessarily know why the heated plastic sheet behaves the way it does in non-isothermal conditions. When compared to injection molding, for example, where melt flow data is standard and well-understood, thermoforming can be considered a solid-state transformation of polymer, meaning that the melt flow index is not a relevant yardstick. The new direct test methodology breaks down the thermoforming process into component parts, each with unique and discrete sets of variables, instead of relying on indirect test methods such as DSC, HDT or hot tensile.

Dharia’s proposed system, Technoform, provides rapid data acquisition with built-in software that measures the

force and speed required to form the heated plastic. Where ToolVision provides near-real time data on the actual process, Technoform essentially proposes to improve the thermoformability of the extruded sheet before it arrives in the converters facility. The primary test measures and analyzes several key performance properties including rate of heating, sag, melt strength, drawability, rate of cooling, shrinkage and plug-sheet interactions. The outputs can be used to evaluate shrinkage, determine the effect of recycled content and/or additives, find constants for BKZ simulation models or they can be used to define, compare and control sheet material from lot to lot. A combination of the two technologies could theoretically reduce the variability of thermoforming to a much lower level, increasing efficiencies and reducing waste associated with trial-and-error.

Advances in Heavy Gauge Thermoforming

Fraunhofer Dresden presented preliminary data from tests designed to form parts with new Forming Air Impact Technology (FIT). Unlike conventional pressure forming, the Fraunhofer experiments sought to measure wall thickness distribution through FIT. The technology uses special nozzles to control several parameters including angle, temperature and direction. Air flow velocity affects the heat transfer coefficient which impacts material flow and therefore distribution. The simulations were impressive, though the actual data did not reveal a great degree of difference between a conventionally formed part with vacuum only and a part formed with the forming air

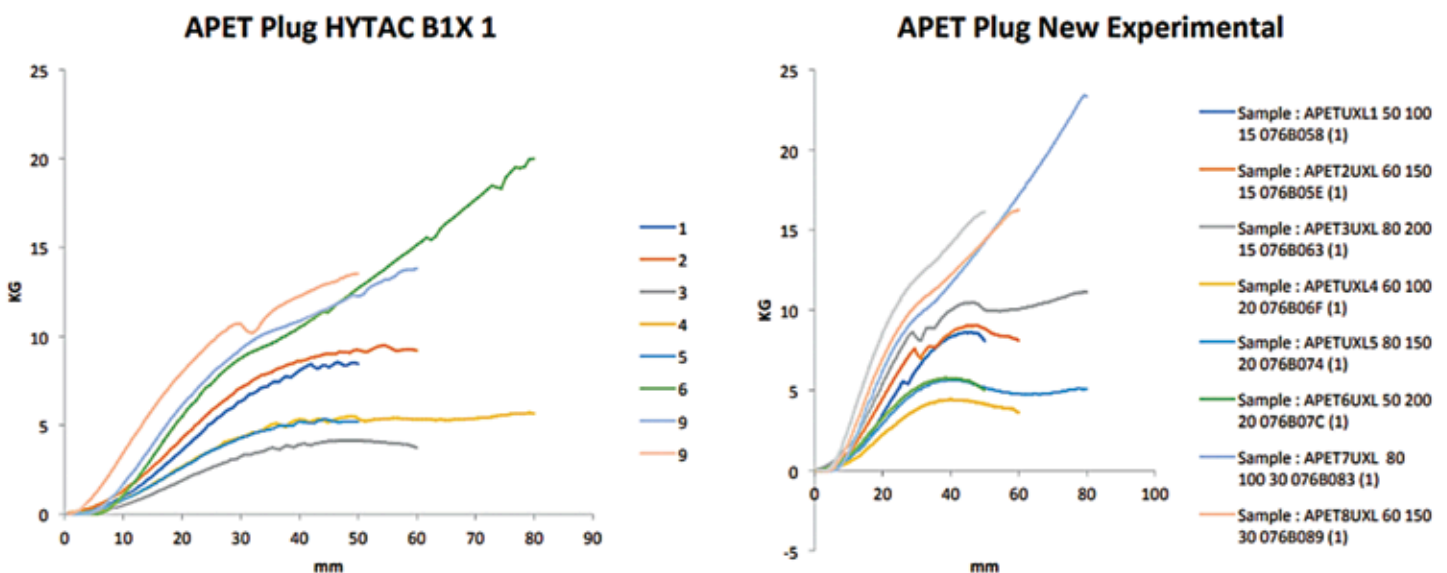


Image 2: Effect of different plug materials on APET sheet, force vs. distance / (Source: Dr. A. Dharia, Transmit Technology Group)

nozzles. Further experiments will also use mechanical plug assists which have been shown to improve wall thickness distribution.

Forming Air Impact Technology (FIT) Influence Parameters

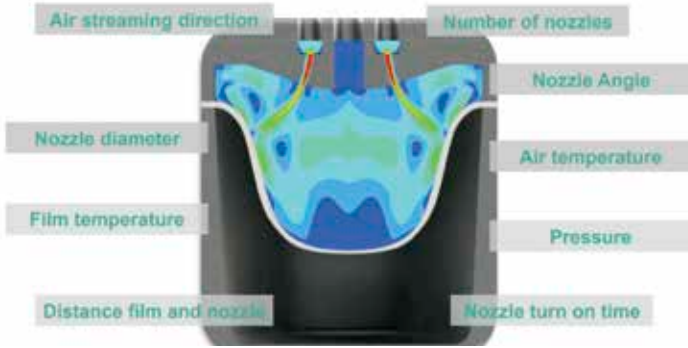


Image 3: Influence Parameters of Forming Air Impact Technology in Heavy Gauge Thermoforming (Source: Fraunhofer IV; SPE European Thermoforming Conference 2018)

Sekisui (Bloomsburg, PA) presented data from tests done on bonding of thermoplastics. Increased strength and reduced weight are two primary drivers for users of thermoplastics sheet, with applications in transportation leading the way. World passenger fleets are projected to double by 2020, with Asian markets driving the majority of demand. According to data presented by Sekisui, between 1990-2014 there has been a 37% improvement in fuel efficiency due in large part to weight reduction associated with converting steel and aluminum to lighter composites and engineered thermoplastics. Twin-sheet forming, fiberglass reinforcement and SRIM reinforcement all offer varying degrees of improvement in strength-to-weight ratios, a major driver in both aviation and rail transport sectors. Examples of successful conversion include seating components, including a majority of parts in first/business class cabins where plastics offer greater freedoms for industrial designers.

Parts Competition

Both heavy-gauge and thin-gauge parts were submitted again this year, as the ETD continues the tradition of celebrating innovation in both thin-gauge and heavy-gauge thermoforming. Winners were announced in several categories:

■ **Automotive:** RPC Promens (Kópavogur, Iceland) for a partition between the cargo and passenger compartments

in a passenger vehicle. The material, 5.9mm thick ABS gray high-impact, UV stabilization on both sides, was supplied by Senoplast Klepsch + Co. GmbH (Piesendorf, Austria) and the mold was produced by Lanulfi (Monticello Conte Otto, Italy).



Image 4: Heavy Gauge Part Competition Winner (Automotive): RPC Promens (Kópavogur, Iceland) This interior door demonstrates very complex shapes - high pre-blow (600 mm) prior to forming. This part is deemed a high security part according to ISO 27956. (Courtesy RPC Promens)



Image 5: Thin Gauge Part Competition Winner: Milliken Chemical (Spartanburg, SC, USA) PP tray from Milliken illustrated weight reduction from 14g to 12g tray (16%) while maintaining optical clarity and improving impact strength over PET version. (Courtesy Milliken Chemical)



*Image 6: Heavy Gauge Part Competition Winner (Automotive): Walter Pack (Bizkaia, Spain)
This original application by Walter Pack highlights translucent or opaque declination in automobile cladding. (Courtesy Walter Pack / SPE ETD)*

■ **Food packaging:** Milliken Chemical (Spartanburg, SC) for a hot-fillable thermoformed tray made of polypropylene clarified with Milliken's Millad® NX™ 8000.

■ **Automotive:** Walter Pack (Bizkaia, Spain) for a backlit thermoformed real stone decorative "baguette" made from 1mm thick film made of natural stone layer adhered to a transparent thermoplastic.

■ **Medical:** VDL Wientjes Roden (Roden, The Netherlands) for a cast-acrylic incubator lid made on a chrome-plated steel tool.

Recycling & Sustainability

The plastics industry in Europe has been at the forefront of developing circular economy models. According to data from Plastics Recyclers Europe (PRE), of the 60MM tons of Europe's plastics consumption, 40% is packaging-related. Of the 26MM tons of the continent's plastic waste, 63% is packaging-related. Both figures point to a large opportunity for increased recycling, or continued concern for resource depletion and environmental degradation. They also illustrate the continuing challenges associated with viable economic models for recycling difficult-to-manage materials. End-of-life data shows that 35% of all plastic waste is used for energy recovery (mostly incineration), 25% is collected for recycling, and 40% is landfilled. Of course, the data is a composite of EU-27 countries, with some leaders and some laggards, differing investment levels and divergent policies on waste management.



Image 7: Heavy Gauge Thermoforming Parts Competition Winner (Medical): VDLWientjes Roden (Roden, The Netherlands)

Perfect transparency and excellent material distribution of this premature baby incubator cover made from 6mm cast acrylic from Altuglas contributed to the judges' decision. The cover illustrates the superb quality that can be obtained on important parts in thermoforming in front of an injected part. (Courtesy VLDWientjes Roden)

	Primary Processing / Production	Recycling
Production Capacity	60,000,000 tons	3,000,000 tons
No. of companies	60,000	1,000
Employment	1,500,000 people	30,000 people
Turnover	€350bn	€2bn

(Source: *Plastics Recyclers Europe*)

Two major objectives laid out by PRE, targeted for 2030, are that all plastics packaging will be recyclable and that half of all plastics waste will be recycled.

Willemijn Witteveen from Avantium, a renewable chemistry company, focused on the opportunities for sustainable materials, that is, materials derived from non-petroleum feedstocks. But with plastics' share of global oil consumption set to rise from 6% today to 20% in 2050, what external factors are going slow down or reverse this rate of growth? Recent EU policies call for 80% reduction in carbon footprint in the next 30 years. Though promising, the renewable portfolios of Avantium and others in the green chemistry space have not yet achieved economies of scale, with many well-funded efforts burning through cash while being proven in the lab. The primary challenge from a chemistry perspective, according to Dr. Witteveen and many other observers, is to develop novel renewable polymers from biomass or CO₂ that can compete on cost and performance. Beyond the economics, new polymers must also meet end-of-life environmental criteria because they must be an order of magnitude more biodegradable than current oil-based olefin and ethylene materials. Avantium has major partners both upstream (BASF, universities) and downstream (Lego), and a new, accelerated approach that aims to move ideas quickly from the lab to the field, to 'fail fast' perhaps, in the ongoing search for the holy grail of renewable, sustainable and affordable polymers.

As it relates to thermoforming, several challenges remain in truly closing the loop for recycling and reuse of valuable polymers. Paolo Glerean of Aliplast (Treviso, Italy) provided an overview of a PET thermoforms recycling project in Europe. While PET bottles are readily recovered and recycled, there has been a push on both sides of the Atlantic to expand collection efforts to include PET thermoforms such as clamshells and other packaging trays. Approximately 10% of household plastic packaging waste

is PET trays, though PET thermoforms represent 18% of virgin PET output by weight. Of the 950kt of PET sheet consumed in Europe, 50% is rPET (post-consumer), 40% is virgin, and 10% is industrial waste. Importantly, 40% of these trays are monolayer structures while the remaining 60% is shared equally by PET/PE and high-barrier films. Thomas Tang of Faerch Plast (Holstebro, Denmark),

offered examples of concrete initiatives already in effect at one of Europe's largest thermoforming companies. Innovations such as secondary recess designs and patents for ultra-low stacking parts have helped reduce CO₂ emissions from freight by 67%. These successes, both in material conversion and solid LCA data on plastics, lead to further market share capture from competitive materials such as cardboard and aluminum. Tang identified two major challenges for the plastics value chain: dual material items including APET/PE or PP/EVOH continue to pose problems of contamination in the recycling stream, though it has been pointed out that up to 5% of EVOH by weight does not pose a contamination risk; and ongoing problems with sorting black plastic.

The PETCORE Europe working group, in coordination with other groups such as the Ellen MacArthur Foundation, has sought to address these concerns by establishing specific guidelines for improved recyclability through fundamental redesign and innovation. Key elements include consideration of labels, absorption pads, lidding films and ink-based printing decoration. Color choice also represents an important design choice given the well-documented challenges with NIR detection and sorting techniques for black plastics.

Glerean presented findings and preliminary conclusions from a recent study in which PET thermoforms were commingled with bottles and recycled into pellets and pre-forms. With mixed trays added to the PET bottle stream, the potential for contamination increases which can compromise the final product. Technology and systems from Tomra (NIR equipment), Sorema (washing, grinding) and Starlinger (pelletizing) were used to ensure minimum bale cleanliness. Flakes made from thermoformed trays, however, tended to crystallize, becoming opaque and more brittle, with a high amount of fines and dust generated. The final mechanical properties of the recycled PET were reported as "good", with modulus test bars

and tensile strength measured. The results provide a foundation for cautious optimism, though the authors call for continued investment in sorting technologies along the entire value chain.

On to 2020

Anecdotal evidence suggests that exhibitors and attendees were very satisfied with the quality of networking and business opportunities in Rome. The thermoforming industry continues to power ahead in all global markets, driven both by ever-changing consumption habits in food packaging and advances in engineered polymers that increase strength and reduce weight in larger components. Recycling and sustainability remain critical areas for improvement, however, as converters and brands are forced to reckon with increased levels of output, while the waste collection and management industries struggle to keep up.

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American Red Cross Receives Donation from SPE Thermoforming Conference Participants

by Lesley Kyle, CMP
SPE Thermoforming Division Conference Coordinator

Just days before the 2017 SPE Thermoforming Conference was set to begin in Orlando, the Thermoforming Division canceled the event in response to the threat posed by Hurricane Irma. Soon after the cancellation was announced, the Division outlined refund options for registered attendees and exhibitors. Options included the transfer of fees to the 2018 Conference, full refunds, and the opportunity to donate fees to the American Red Cross's Hurricane Irma Relief Fund.

With the generous support of conference sponsors, exhibitors and attendees, more than \$10,000 was donated to hurricane relief efforts. In October, the American Red Cross issued a one-month progress report in a press release (excerpts follow):

Hurricane Irma made landfall in the Florida Keys on September 10 as a Category 4 storm, the strongest hurricane to make landfall in the U.S. since 2005. Before hitting the U.S. mainland, the massive storm carved a path of destruction through the Caribbean, devastating several island countries, including the U.S. Virgin Islands and parts of Puerto Rico. In Florida, Irma caused damage from Naples to Jacksonville and brought flooding and wind damage across the southeast as far as Georgia, Tennessee and the Carolinas.

As of October 10, the Red Cross raised \$56.4 million in designated donations for the Irma relief effort. All donations earmarked for Hurricane Irma will be used to support relief and recovery efforts for this disaster. The following are examples of how donations are being used:

■ Donations pay for provision and delivery of food, shelter and relief items, accounting for \$29.6 million of

our preliminary budget estimate. In the first month, the Red Cross served more than 1.5 million meals and snacks, provided nearly 650,000 overnight stays in shelters, and distributed more than 1 million relief items.

■ Donations pay for health and mental health services, accounting for \$1.7 million of our preliminary budget estimate. In the first month, the Red Cross provided more than 49,000 services to support and care for people.

■ Donations pay for immediate financial assistance, accounting for \$7.8 million of our preliminary budget estimate. To help people recover and get back on their feet, the Red Cross has opened more than 11,000 cases, reaching more than 37,000 people across Florida.

■ Donations pay for individual and community recovery programs, accounting for \$12.2 million of our preliminary budget estimate. The Red Cross is working alongside our community partners to plan for long-term recovery services, such as additional financial assistance for people who need extra help with their recovery efforts and programs to help the hardest-hit communities rebound and prepare for future disasters.

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Twin Screw Extrusion System Developments To Process Bioplastics

By Charlie Martin, Leistritz, Somerville, NJ, USA

Introduction

Twin screw extrusion is a preferred manufacturing methodology to compound bioplastics with fillers, additives and fibers. Materials include PLA, PHA, PGLA and TPS which are converted into a variety of products, such as film/sheet for packaging, fibers and foamed parts, as well as medical devices such as sutures and ligament anchors. PLA, which is heat and shear sensitive, as well as torque intensive, is the most prevalent biopolymer processed today.

Twin screw extruders (TSE's) utilize modular barrels and screws. Segmented screws are assembled on splined shafts. TSE motors transmit power into the gearbox/shafts and rotating screws impart shear and energy into the materials being processed. Free volume is an important design parameter for any TSE, and is directly related to the OD/ID ratio, which is defined by dividing the outer diameter (OD) by the inner diameter (ID) of each screw. With a smaller screw shaft, increased free volume is possible, but attainable torque is sacrificed.

Torque is also an important design factor, and typically limited by the cross-sectional area of the screw shaft, the shaft design, metallurgy and manufacturing technique. Deeper screw flights result in more free volume, but with less torque, since a smaller diameter screw shaft is mandated. Based on the use of a symmetrical, hammered splined shaft, a 1.55 OD/ID ratio has been deemed to result in the best balance of torque and volume.

Symmetrical splined shafts, formerly the industry standard, induce both tangential and radial force vectors into the power transmission train. The resultant force is not optimized, as the radial force is not applied in a beneficial direction. An asymmetrical splined shaft design is now available that isolates the tangential force vector and results in higher torque transmission with a smaller diameter shaft. Hence, a 1.66/1 OD/ID ratio with deeper flight depths, higher free volume and increased torque is now perceived as optimum by many. The deeper flights result in a lower average shear rate with increased torque, a combination particularly beneficial for PLA processing.

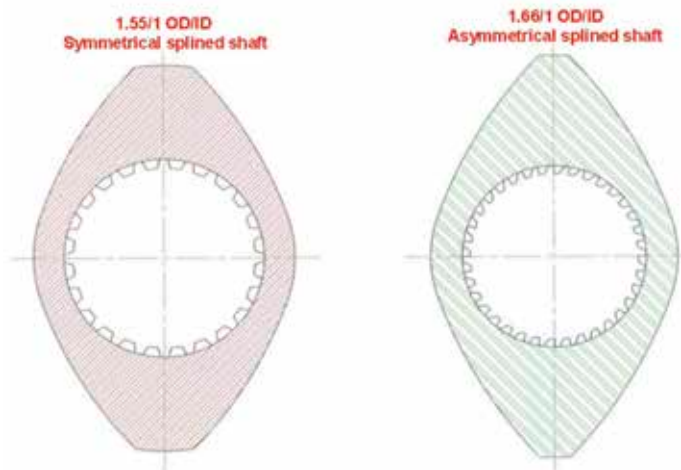


Figure 1: Comparison of 1.55 vs 1.66 OD/ID TSE shaft/screw geometries

Tests

Various TSE experiments processing PLA have been performed utilizing TSE's with a 1.66/1 OD/ID ratio, described as follows:

Test #1- PLA pellet output rate checks: Neat PLA

(NatureWorks™ 2002D) pellets were processed on ZSE-27 HP model (27 mm dia. screws, 4.5 mm flight depth and 1.5 OD/ID) and ZSE-27 MAXX (28.3 mm dia. screws, 5.7 mm flight depth and 1.66 OD/ID). The TSE screws rpm was set at 300, 400, 600 and 1200. At each rpm the rate was increased until a boundary condition was encountered, which ranged from 60 kgs/hr (at 300 rpm) to 170 kgs/hr (at 1200 rpm). All samples were torque limited, not feed limited. The ZSE-27 MAXX yielded approximately 10% higher rates with lower melt temperatures as compared to the ZSE-27 HP model.

At elevated rpms the resultant melt became problematic with both models. It seems that the gentler melting mechanism inherent with the MAXX design consumed less torque and allowed slightly higher throughputs, while the lower average shear rate inherent with a deeper flighted TSE resulted in a lower specific energy and melt temperature.

Test #2- Direct extrusion of filled PLA sheet: Testing was performed to compound PLA (2003D) with 15-25% CaCO₃ (Specialty Minerals EM Force™) to develop a process to

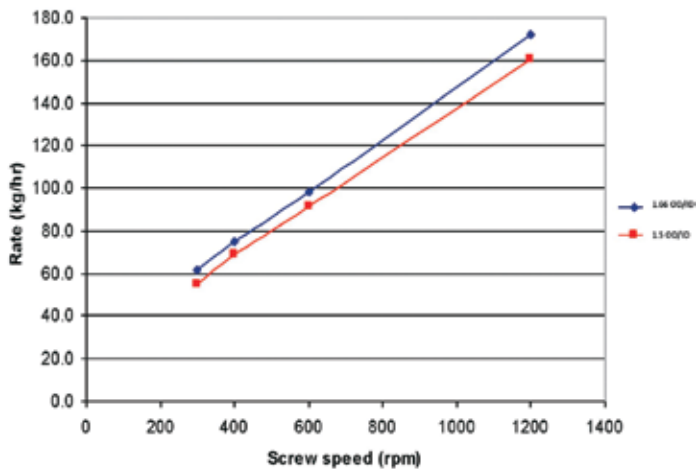


Figure 2: Maximum rate comparisons 1.5 vs 1.66 OD/ID ratios

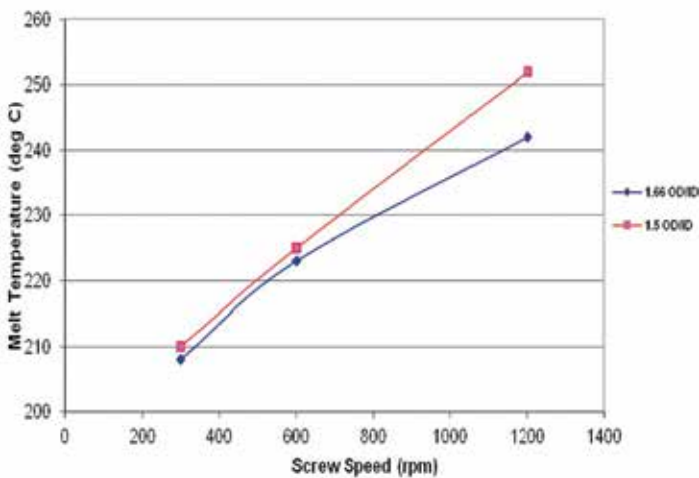


Figure 3: Melt temperature comparisons for same tests

convert raw ingredients directly into a sheet, bypassing the pelletization step and avoiding an extra heat/shear history. No additives/dispersive aids were used.

Tests were performed at 40 kgs/hr and 200 screws rpm. Temperature zones ranged between 170 and 180 deg. C. The motor load was 67% and the melt temperature was 182 deg. C. The gear pump inlet pressure was 400 PSI, +/- 80 psi. The following equipment was used: 2 loss-in-weight (LIW) metering feeders; ZSE-27 MAXX (28.3 mm dia. screws) twin screw extruder with 1.66/1 OD/ID ratio and 40 to 1 L/D; side stuffer with 24 mm dia. twin screws; gear pump (10 cc/rev) front-end attachment; 10 inch wide flexible lip sheet/film die; 3-roll stack with 14 inch wide and 8 inch diameter rolls and torque winding station.

Impact properties as measured by normalized Gardiner Impact MFE for the filled product increased by nearly

a factor of 20 as compared to neat PLA. Analysis of the film/sheet samples indicated a well-dispersed product with acceptable surface quality and dimensional stability. Additional scale-up testing seems a worthwhile next step.

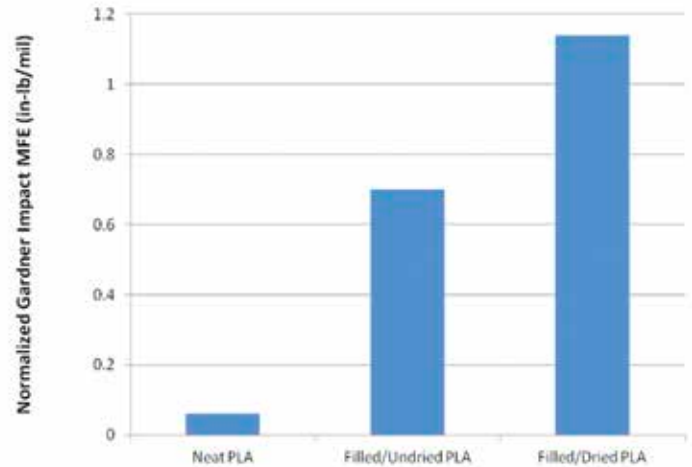


Figure 4: Comparative impact properties for neat and filled PLA

Test #3- Undried PLA pellet and regrind direct to sheet:

PLA pellets (50%) and edge-trim (50%) were metered into the extruder at a total rate of 180 kgs/hr and processed at 250 screws rpm. The temperature zones for the barrels were between 180 and 190 deg. C. The motor load was approximately 70%. The melt temperature was 180 deg. C. Moisture analyzer testing indicated the PLA pellets had 1600-2000 PPM moisture content, and the regrind materials between 2800 and 4200 PPM.

The following is a summary of the equipment: 2 loss-in-weight (LIW) metering feeders; ZSE-50 MAXX (51.2 mm dia. screws), 1.66/1 OD/ID ratio, 40 to 1 L/D with a screw/barrel design to optimize venting efficiencies; gear pump (92.6 cc/rev) front-end attachment; slide plate screen changer (4½ inch diameter breaker plate) with 150 mesh screens; 30 inch wide flexible lip sheet die; 3-roll stack with 40 inch wide and 12 inch diameter rolls with pull roll station and torque winder.

Analysis of the sheet samples indicated a molecular weight loss of between 5 and 8%, deemed successful for this application. The sheet sample was dimensionally stable with an acceptable appearance.

Scale-up: PLA processes are typically heat transfer (and torque) limited, and throughputs do not scale

volumetrically. Based upon the results denoted, de-rating screws rpm and assuming heat transfer limitations, scale-up programs indicate attainable rates of approximately 2000 kgs/hr for a TSE with a 1.66 OD/ID ratio and 140 mm diameter screws.

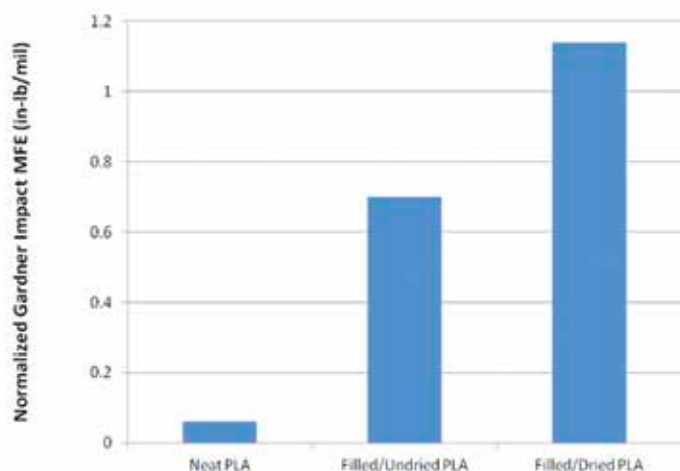


Figure 5: Comparative molecular weight data for dried and undried PLA

Summary

The use of PLA, and other bioplastics, continues to increase for a wide variety of products and applications.

Interest has never been more intense, as evidenced by the high attendance at NatureWorks™ “Innovation Takes Root” Conferences, and the plethora of bioplastics industry events offered today. As research, understanding and commercialization occurs, it seems inevitable that bioplastics will be embraced as an alternative to petroleum based plastics. TSE advancements have and are being developed to improve the process-ability of heat and shear sensitive bioplastics. In many cases, the TSE system only needs to be “tweaked” for success.

References

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3. C. Martin, *Developments to Compound PE/PP with Fillers and Extrude Film/Sheet in One-step*, International Polyolefins Conference (2010), Houston, TX
4. Personal communications, Dr. James Nangeroni, NatureWorks LLC, Jan/Feb 2012

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From the Editor

If you are an educator, student or advisor in a college or university with a plastics program, we want to hear from you! The SPE Thermoforming Division has a long and rich tradition of working with academic partners. From scholarships and grants to workforce development programs, the division seeks to promote a stronger bond between industry and academia.

Thermoforming Quarterly is proud to publish news and stories related to the science and business of thermoforming:

- New materials development
- New applications

- Innovative technologies
- Industry partnerships
- New or expanding laboratory facilities
- Endowments

We are also interested in hearing from our members and colleagues around the world. If your school or institution has an international partner, please invite them to submit relevant content. We publish press releases, student essays, photos and technical papers. If you would like to arrange an interview, please contact Conor Carlin, Editor, at cpcarlin@gmail.com or 617-771-3321.

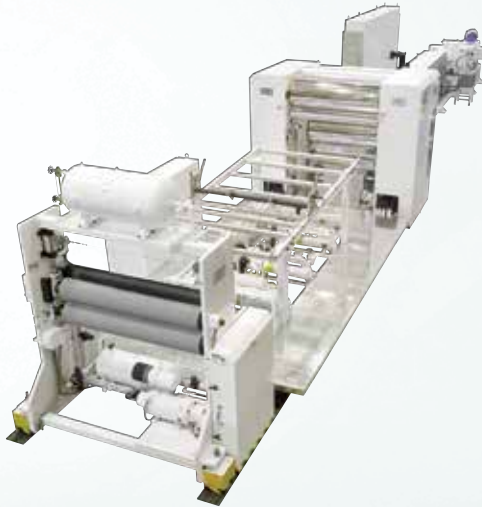


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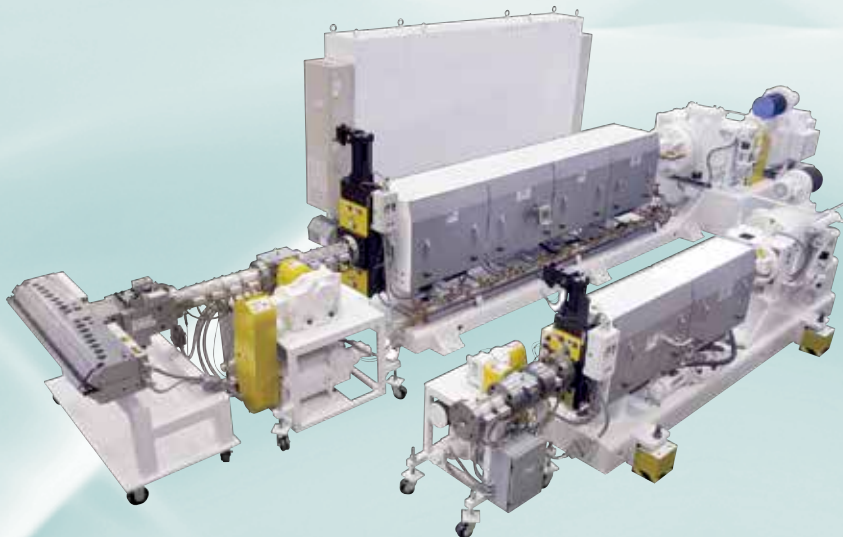
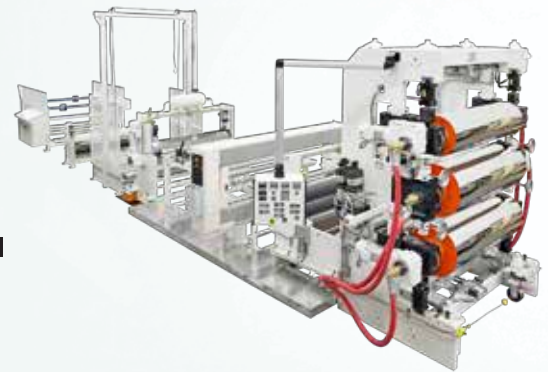
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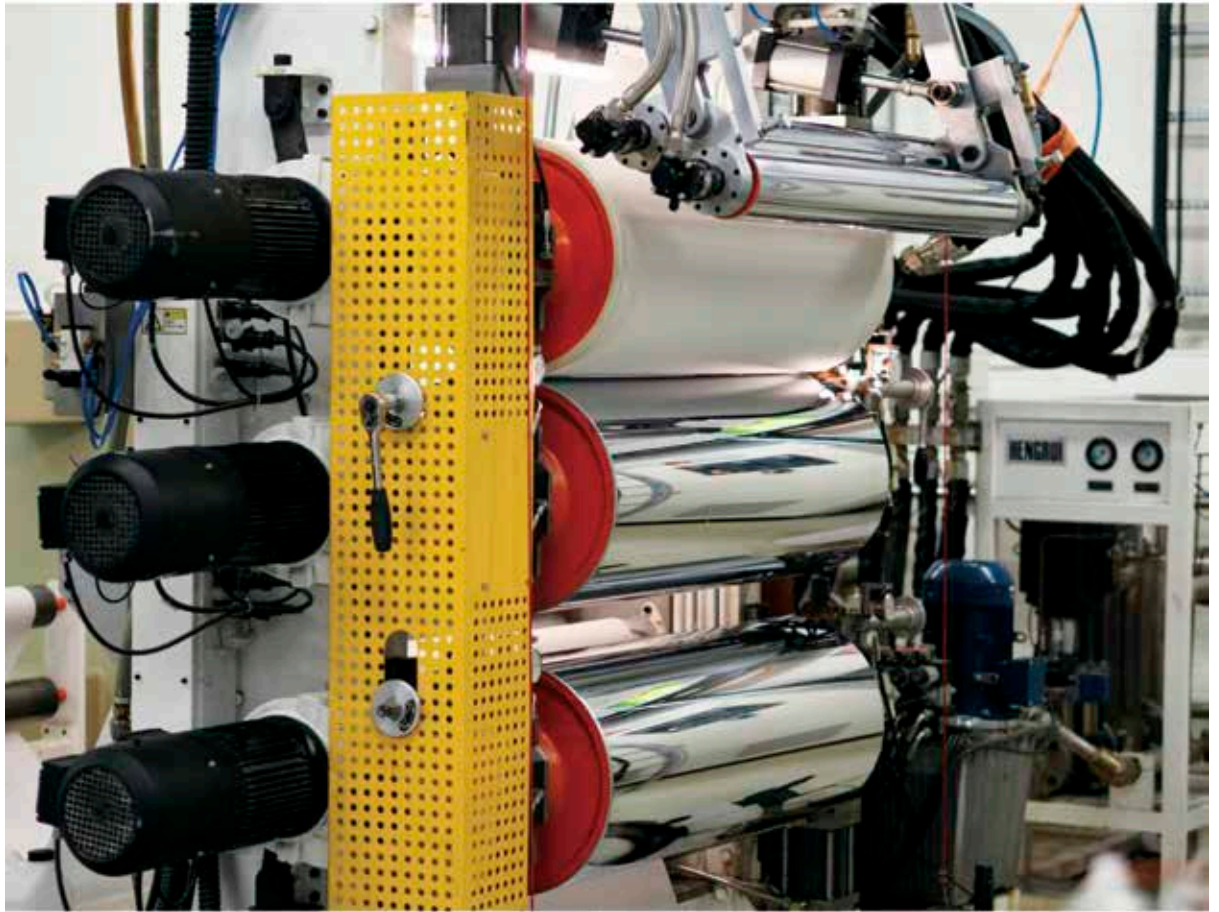


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Scanfill's new rubber roller replaces one of the steel rollers in the manufacturing process.



Scanfill Brings Out The Best in Packaging

In order to meet the market's needs for thinner environmentally friendly plastic film, Scanfill AB has invested in a machine change to broaden its product range of fully or partially oil-free plastics. By replacing one of the steel rollers in the manufacturing process with a rubber roller, Scanfill AB has reduced its minimum range and now has the capacity to produce the environmentally friendly plastic film Scanfill Sheet with a thickness of 150 microns up to 1500 microns.

We constantly strive to develop our Scanfill products to meet the growing demand, says Karl Banke, development engineer. With the thinner Scanfill Sheet, we open up for more applications for both existing and new customers.

Scanfill Sheet consists of 50% minerals, giving it many advantageous features in addition to the superior

environmental benefits. The minerals give the material excellent strength and stiffness, which allows for a thinner film. In addition, Scanfill Sheet has a naturally effective barrier, which can be further enhanced by including an EVOH layer.

Scanfill Sheet is available in up to seven layers, with different colors, and with matte or shiny surface layers. We look forward to exploring the many different uses of Scanfill Sheet together with our customers", concludes Karl.

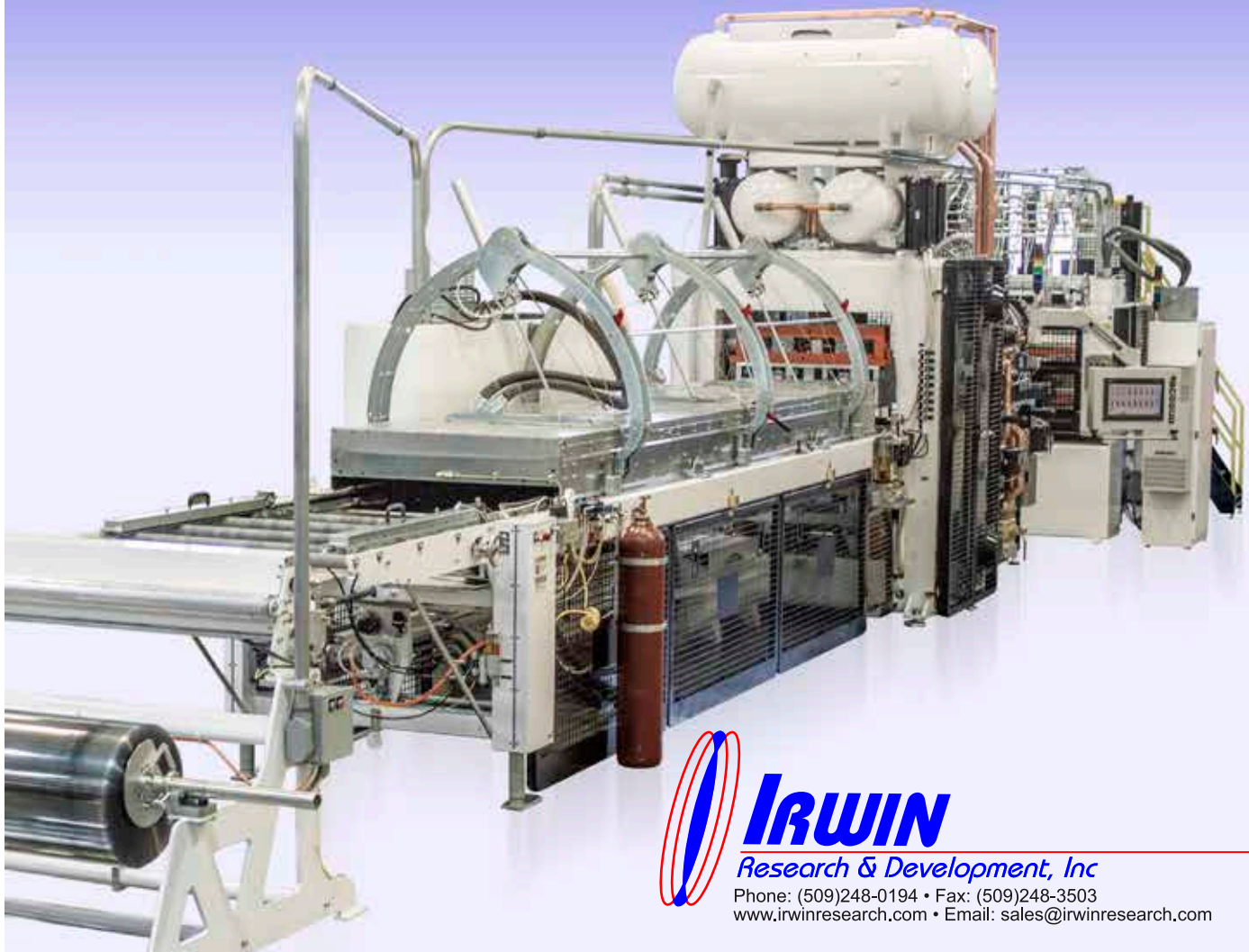
Scanfill AB offers cost-effective and durable packaging materials consisting of 50% minerals and 50% polyethylene or polypropylene which adds strength and impact resistance. The Scanfill materials are approved for food contact, have high heat conductivity, excellent molding properties, and provide increased production speed.

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Foamed PET Sheet for Cups for Hot-fill Applications

Hot drinks and street food are often sold in disposable cups and trays, which must combine heat insulation properties with minimum costs and low environmental impact. At present, these cups and trays are made from different materials such as cardboard and rigid or foamed PS and PP. However, because highly popular PS is the now the object of ecological debate in several countries, alternative materials have become necessary. Roughly a year ago, SML and a partner company started a development project with the aim of employing low-cost APET resin to produce ecologically compatible, foamed cups for hot-fill applications.

The initial situation

As a rule, PET is not employed in the production of containers for hot-fill applications. This is because APET cups lack dimensional stability when subject to heat at the required temperatures. Conversely, crystalline polyester (CPET) could easily meet this stipulation, as it is employed to pack convenience foods, which are heated in ovens at over 200°C. Unfortunately, CPET is expensive and therefore is not used for hot-fill commodities. Consequently, a number of companies are attempting to solve this problem with an approach that involves the use of additives to increase heat stability. Such additives, however, are also expensive and must be employed in high concentrations, which again leads to an uneconomical process.

The solution is a cup that must be:

- Made of foamed sheet
- Suitable for hot-fill
- Produced from a standard APET resin and recycling material at low cost

The development of a PET cup for hot-fill applications

In July 2017, SML started testing a newly developed sheet line at its headquarters in Lenzing, Austria. The primary aim was to manufacture a foamed APET sheet for thermoformed cups that would be suitable for hot-fill applications. The line is designed to produce 3-layer sheet and is equipped with two extruders with a maximum output of over 1 t/h. The sheet has an overall density as

low as 0.62 kg/dm³ (38.7lbs/ft³) and an A/B/A structure with a centre layer that is physically foamed. No special additives are required to enhance the heat stability of the sheet, which is thus suitable for the economic production of low-weight cups with good insulation properties. The sheet is thermoformed by SML's project partner, which is a company that possesses advanced tooling and thermoforming technology.

The cup in the photo has a foamed layer containing 40 per cent post-consumer bottle flakes and can retain its shape even when being filled with boiling water. At the same time, it can be held without burning one's fingers. Therefore, in view of this extremely positive result, the next objective is to render this development suitable for industrial production.

For more information, visit www.sml.at |



Bosch Sprang Launches Innovative Thermoform Tooling System for Polypropylene K-cups

When Keurig / Green Mountain announced that they were planning to switch from a PS/EVOH/PE multilayer sheet to PP/EVOH/PP structure for the ubiquitous K-cup coffee pod, many elements of the thermoforming supply were affected.

In close co-operation with its parent company Kiefel, Bosch Sprang has developed a new patent-pending thermoforming tooling system to produce polypropylene coffee portion cups used in home brewing systems



such as Keurig. The new cups can be recycled in water separation systems due to the low material density of PP of ~0.9g/cc, below that of water (1.0g/cc). The products made with the new tooling system have been statistically analyzed and conform to the generally accepted standards to enable flawless use on coffee pod brewing systems. The tooling system can be adapted to most tilt-bed thermoforming machines. Consequently, it does not require any special machine adaptations.



The propriety technology is based on several unique and innovative multifunctional elements in the tool that enable and control the realization of a very specific material distribution throughout the pod's geometry. This material distribution results in a very high top-load resistance which prevents collapse of the pod during puncture, and a very specific base rim geometry which increases resistance against creasing during puncture of the Pod.

The production of cups can only be consistent if the sheet specification, the process parameters and tool are in balance. The production line is based on a Kiefel KTR 6.1 Speed, a Bosch Sprang 91-cavity tool and Mould & Matic downstream equipment. With its production capacity around 1 billion cups per annum (on a 24/7 basis), this production system represents Kiefel's ability to provide turnkey solutions. On June 21, 2018 the complete production system will be demonstrated during the Kiefel-Kuhne Cup Days USA at Kuhne in Westerley, Rhode Island, USA.

For more information, visit www.boschsprang.nl |

Inaugural China Thermoforming Association Symposium

[Editor's Note: this report also appears in the June edition of Plastics Engineering]

In April 2017, over 600 people crowded into a Guangzhou hotel meeting room designed to hold 400. The preparatory meeting of the China Thermoformer Association (CTFA) served as a powerful indicator of the desire to develop a regional thermoforming association. The CTFA was officially established on April 9, 2018. With 13 founding partners from China, Taiwan, Germany and the United States, the new association seeks "to create a mutually beneficial China thermoforming industrial supply chain platform to serve the government, industry and members and to promote international cooperation." The association is the newest branch of the China Synthetic Resin Supply and Sales Association (CSRA).

At the official press event in Shanghai on April 24, concurrent with Chinaplas 2018, the CFTA announced their formal structure and presented plans for a new economic investment zone in the ancient city of Shaoxing, 200 kilometers south of Shanghai. The deputy mayor of Shaoxing City addressed the audience of 60 people, emphasizing the economic and geographic assets of the region, while inviting outside investment to create and develop a new industrial "thermoforming valley" with private and academic partners. The US members of CTFA, Milliken Chemical and Berry Plastics, have already established a presence in Shanghai and Qingdao,

respectively.

Speakers from the US-based Society of Plastics Engineers (SPE) and its European Thermoforming Division (ETD) were invited to the event to talk about their own development as volunteer-based associations, while also providing some insight into current trends in thermoforming. Both Conor Carlin, SPE's VP of Marketing and Communication and Editor of Thermoforming Quarterly magazine and Antonio Staffoni, President of the ETD, spoke through translators to the assembled group of local dignitaries, Chinese industry press and regional converters and toolmakers. Common themes of faster machines, more complex tooling, and new multilayer sheet construction appear in both North American and European markets with food and medical segments highlighted as drivers of innovation.

Alfred Gatchalian, CEO for Glades Greiner Asia Plastic Technology (Shanghai) Co. Ltd., offered a pan-Asian perspective, part of which mirrored the western trends of environmental concerns and public attitudes toward plastics. China will take the lead in setting trends for packaging due to the sheer size of its own market, and also because the rates of growth and change are most dynamic here. This will spill over into ASEAN countries, Gatchalian believes. With operations on multiple continents, Greiner works closely with some of the largest multinational food and beverage companies to design, develop and supply a variety of cups, trays and other packaging items. Greiner is a founding partner of CTFA and played an instrumental role in setting up the first thermoforming technical training sessions alongside the Zhejiang Mechanical & Electrical Institute. |



The founding members of the China Thermoforming Association gathered in Shanghai, with local dignitaries and SPE leaders.

ANTEC in Orlando

The SPE Council meetings were held prior to ANTEC 2018 in Orlando, Florida. At the beginning of proceedings, President Raed Al-Zubi called for a moment of silence to honor the passing of two distinguished SPE members, Dr. Costel Denson and Mr. Gautam P. Shah.

The new SPE President, Dr. Brian Grady, introduced himself to Council and presented his thoughts on the state of the Society and the role of the SPE Foundation. He shared his list of priorities which include enhancing the ANTEC experience, committing to SPE's global presence and working on membership retention. He also restated the Executive Board's commitment to full transparency. In addition, this meeting marked the arrival of newly-elected Executive Board members who were seated between Council I and II:

- Dr. Raymond Pearson (VP Technology & Education)
- Dr. Scott Eastman (VP Sections)
- Dr. Brian Landes (President-Elect)

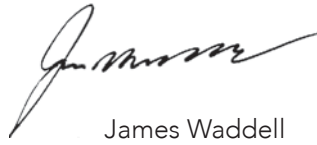
Clear and relevant governance is the foundation of a well-run society and SPE continues to refine its policies and by-laws. Several items were amended and approved during Council thanks to the diligent leadership of Councilor Bruce Mulholland. At the Council Committee of the Whole (CCOW), Councilor Babli Kapur was re-elected as Chair.

All presentations and data discussed during Council meetings are available on The Chain on Leadership Lane. We encourage everyone to take the time to review this information to get a full understanding of the Society.

Financial Review

The 2017 audit process is complete and there were no findings. The payment of \$1.5MM from Wiley Publishing was re-booked as deferred income over a 10-year period following advice from the auditors. There were no questions from the floor.

The 2018 budget was presented to Council. This budget was approved by the Finance Committee and the Executive Board in March 2018. SPE is projecting a small loss for the year. CSE Farrey reviewed the cost control measures implemented to-date, including the new



James Waddell



technology platform and the winding down of earlier contracts. Stephanie Clark continues to generate new non-dues revenue through corporate sponsorships and other programs.

At the time of writing, ANTEC registrations were at 1500. Chief Staff Executive Pat Farrey noted that there were changes to the ANTEC pricing model in 2018 and that 180 volunteer members will attend at no charge. Farrey stated that ANTEC was projected to generate \$140k in profit.

SPE Foundation

SPE Foundation Director, Eve Vitale, reviewed the mission and board structure of the organization. She presented the new Impact Report which illustrates the good works provided by the Foundation. She reviewed the PlastiVan successes in 2017 which included the addition of several new educators. The Foundation is looking for assistance in the Western US and with more corporate sponsors. The value of scholarships and grants YTD is \$54k.

Strategic Commentary

CSE Farrey outlined his 4 priorities for the Society:

- Technology
- ANTEC
- Staffing
- Profitability

Farrey presented the new SPE organizational chart and reviewed future activities and strategic actions which include establishing the Plastics For Life™ event as a major international industry award. He echoed President Grady's commitment to SPE's global members and volunteers after having spent time in Europe, Middle East and East Asia. He stressed the importance of SPE as a people-centric organization.

Farrey outlined the chapter support model as it exists today. He directly addressed the conflict and differences of opinion between what SPE HQ offers, what it charges for

services, and what chapters perceive as valuable. Farrey presented detailed slides on all service offerings from SPE which can be viewed on The Chain. Farrey challenged councilors to review ANTEC programming and the new website as examples of improved functionality and new capabilities delivered by SPE staff. From a business perspective, SPE currently spends \$600k on servicing small events for a return of \$300k. This is not sustainable and is a primary cause of negative operational results for the society.

Related to technology implementation, proposed changes to the member dues model were hotly debated on the Council floor. Several Section councilors objected to a proposed variable pricing dues model that would allow individual chapters to assign a dollar value to their membership. The previous model automatically included 2 group affiliations, including a geography-based Section assignment. A majority of councilors ultimately voted to revert to the previous model.

Executive Board Reports

The Executive Board members continue to work in

functional roles as outlined by the new governance model. As such, individual members provided detailed updates on their respective portfolios. Notably, the VP of Technology & Education presented new and exciting details on a partnership with Virginia Tech on Additive Manufacturing coursework. The technical review will take place in the 2nd half of 2018 with an initial course offering scheduled for 2019. This is an excellent opportunity for SPE to create real value for members while providing important technical oversight in a dynamic area for plastics professionals.

After several rounds of fireside chats and continued dialog, Sections and Divisions still have room to maximize the value they can deliver to SPE members. The EB and Council recognize that many members do not cross-pollinate and more can be done to ensure vibrant TopCons and networking opportunities. Section and Division leaders can do more to connect with each other and learn about each other's events.

The next Council meeting will be held in Charleston, SC on September 21-22. |



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Pittsburg State car design and racing team.



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RC Car Competition

The SPE Thermoforming Division has a new program to support student innovation! This design competition will culminate in a **race to the finish** at this year's conference.

- Entrants will be supplied with a sponsor-furnished electric radio-controlled car.
- Entrants must design, manufacture and decorate the car body to be mounted on the chassis. Modifications to the chassis/motor are not permitted.
- The car body must be formed using clear plastic: PET, PETG, Acrylic or Polycarbonate. The body must be produced using the vacuum/thermoforming process. Cars will be judged for presentation and thermoforming complexity. The only design limitation is your creativity!
- Students may participate as individuals or in teams. Each entrant is required to submit an article on their RC car project for publication in *SPE Thermoforming Quarterly*® magazine.
- Entrants will race each other on an indoor race track at the conference in Fort Worth.
- Student participants may qualify for travel expense support based on need.
- All participants - regardless of race placement - will keep the RC car they designed. Winners will receive cash prizes.

Interested in sponsoring a student or student team for \$300? Contact Lesley Kyle, CMP, Conference Coordinator, at thermoformingdivision@gmail.com or phone +1 (914) 671-9524.

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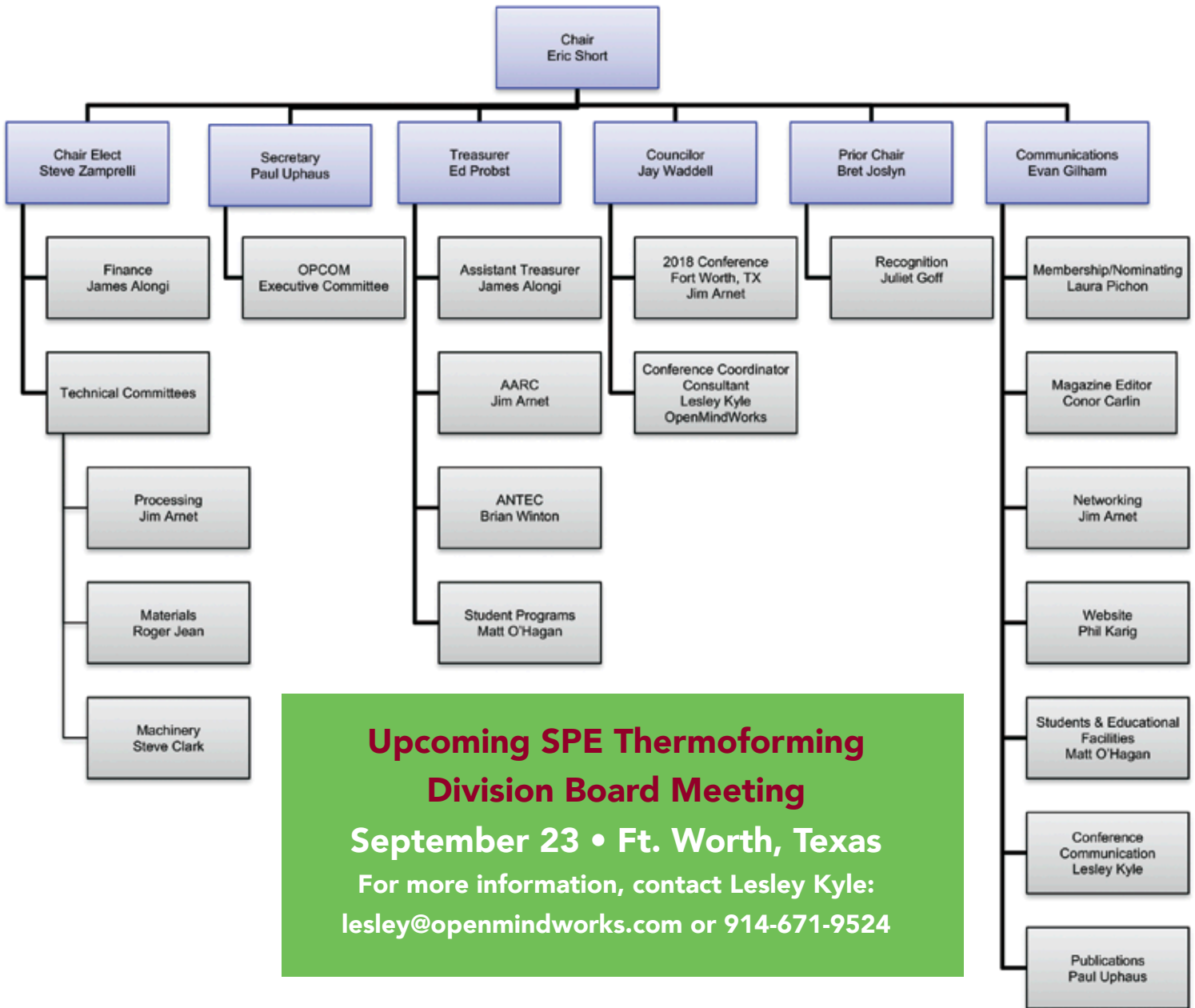


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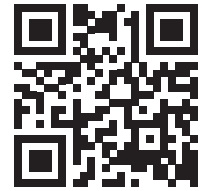
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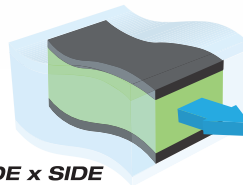
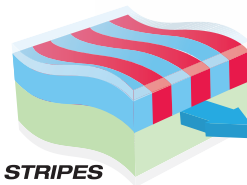
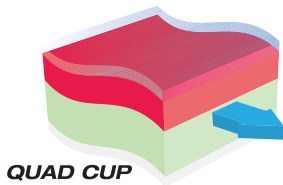
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