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Cover image: Example of thermoformed packaged used in electronics packaging (Adobetock Photography).
Sentry or Shill?

Those of us in the plastics industry read news of plastic pollution with dismay, both because of the environmental damage caused by litter and because of the knee-jerk reactions in the form of bans. In both cases, industry professionals are confronted with a thorny dilemma: how to educate more people about the science of polymers and their incredible benefits while not coming across as industry shills? In this issue, we offer several important papers that highlight the importance of plastics in the packaging sector, in electronics and food specifically, two critical areas in today’s modern world.

While there has been much discussion about the role of plastics in protecting global food supplies and reducing food waste, there has perhaps been less discussion in the realm of electronics. Author Jimmy Shah of Impact Plastics provides a clear and thorough overview of thermoformed packaging for protecting and shipping highly sensitive electronics components (pp. 10-12). And though it is not simple to explain the difference between surface resistivity and volume resistivity to the average consumer (and why it matters), as industry professionals we have a duty to ensure that such complexities are not ignored when public policy is being crafted.

SPE’s flagship conference, ANTEC*, will feature several important talks and presentations on the global plastics question. As a technical conference, ANTEC does not usually feature a lot of thermoforming-related papers, though the “Plastics for Life” competition will feature several thermoformed parts this year. The interface between extrusion and thermoforming is very tightly linked, yet there are over thirty papers on extrusion (granted, they are not all related to sheet) and zero on thermoforming. This should be a cause for concern in our ranks because there are many innovative parts being created through thermoforming as opposed to other processes.

On the topic of innovation, we offer two new “Innovation Briefs” in this issue. The first is a web-based calculator for barrier properties from Norway-based Norner that allows materials engineers to simulate rates of oxygen (OTR) and water vapor (WVTR) transmission through several plastic materials (see story on pp. 18-20). The second is the commercial launch of crystallized polyactic acid (cPLA) for food packaging applications (pp. 22-26). Global macro trends related to urbanization and meals on-the-go overlap with increasing sustainability demands. And though PLA faces its own challenges in difficult end-of-life management scenarios, continued growth around the word suggest that the corn-based plastic will be part of the material engineer’s toolbox for some time.

It is also time for you to send us your nominations for Thermoformer of the Year. The annual award, presented at our conference (September 9-11 in Milwaukee, WI), celebrates the leaders and innovators in the thermoforming world. The application form can be found on our website and on p. 30. The deadline is March 31. Send all submissions to Awards Chair, Juliet Goff at juliet@kal-plastics.com.

Yours,
Eric

*ANTEC will be held in Detroit, MI from March 8-21.
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Brentwood Adding Production in Mexico

By Stephen Downer, Plastics News

January 13, 2019 – Pennsylvania thermoformer Brentwood Industries Inc. is adding a second production line to its medical manufacturing facility in the Mexican border city of Tijuana which it opened less than a year ago.

“The future of Brentwood Mexico is bright with expansion plans already underway to add another production line in January 2019, just eight months after operational launch,” the Reading-based company said in a December news release.

Tijuana is Brentwood’s second such facility. The leased plant is new and covers 35,000 square feet, including a 7,500-square-foot ISO Class 7 clean room.

Brentwood made the Tijuana facility’s existence public in February but did not hold an official opening ceremony until December. The new operation enables the company to “more deeply engage Baja California’s medical and electronics industries,” Brentwood said in the release.

Tijuana is in the northwestern state of Baja California and lies across the U.S.-Mexico border from San Diego.

Founded in 1965, family-owned Brentwood supplies the medical industry with custom thermoformed and injection molded items for device packaging, trays, components and housing for imaging and diagnostic equipment.

It also produces plastic solutions for cooling tower, water treatment, transportation, storm water management, construction and battery applications. The Tijuana facility is Brentwood’s ninth.

Berry Considering Bid for RPC

By Jim Johnson, Plastics News

February 1, 2019 — Apollo Management Group LLC has made a firm, multibillion-dollar offer for global plastics company RPC Group plc, but the ball may be on its way to Berry Global Group Inc.’s corner. At least for now. Berry has signaled potential interest in making a rival bid for RPC but has yet to commit to an actual offer. That move gives the Evansville, Ind.-based company time to perform due diligence on RPC and determine whether it wants to make a rival bid. And while the move, under United Kingdom financial regulations, gives Berry some time, the company still must work toward a decision in a timely manner.

Berry gets the wiggle room because Apollo came out with the unusual move of declaring its $4.3 billion bid for Rushden, England-based RPC as a “final” offer. That wording has specific meaning in U.K. regulatory language and precludes Apollo from upping the number in the future.

So Berry, or any other company for that matter, has the opportunity to come in and sweeten the pot on Apollo’s offer that was previously accepted by RPC.

Berry CEO Tom Salmon, on a Feb. 1 conference call to discuss quarterly financial results, said he could not field questions on the situation.

“We are considering a possible offer for RPC Group plc,” Salmon told stock analysts on the call. “We will utilize our proven, disciplined approach to complete our diligence process and access the shareholder value creation opportunities alongside other opportunities.”

Salmon, in his brief remarks, was not specific about those “other opportunities.”

“There is no certainty that an offer will be made,” he warned. “Further announcement in relation to RPC will be made … when appropriate.”

While Berry was showing an interest in RPC, the Apollo bid also received a boost from an existing shareholder, according to Plastics News Europe, a sister publication of Plastics News. Eminence Capital announced that it had sold 726,169 of its controlled shares in RPC to Apollo on Feb 1. The New York-based hedge fund sponsor, which holds more than 7 percent of RPC shares, also confirmed that its letter of intent was valid in respect of its remaining 2.27 million RPC shares, PNE reported.

Prior to the publication of its Jan. 23 offer, Apollo had received a letter of intent from Eminence Capital, which said it would vote in favor of the acquisition.
“There is generally a sense of silent approval among the shareholders for the Apollo takeover,” a source close to the deal told Plastics News Europe.

When Berry Global Group changed its name from Berry Plastics Group almost two years ago, it was a sign of future aspirations of the plastics company. Adding the word “global” was meant to send a message to the market, the company’s customers and even potential takeover candidates.

Berry, thanks to a string of acquisitions in recent years and over time, has grown into a company with $7.9 billion in annual sales, and the potential acquisition of RPC would add another nearly $5 billion in annual sales in one fell swoop. It’s a company that, over the decades, has relied on dozens of acquisitions to grow, and that approach is a source of pride in the company’s culture.

RPC dates to 1991 when a manager purchased five locations in the United Kingdom from Svenska Cellulosa AB, or SCA, a Swedish company better known for its paper and forest products businesses. That firm has grown tremendously in size over the years, thanks in part to its own series of acquisitions. That includes 2017’s purchase of Letica Corp. of Rochester Hills, Mich., a deal that more than doubled its North American business by adding 13 plants at the time. The company, also in 2017, acquired Astrapak of South Africa, a maker of molded and thermoformed plastic packaging, as part of a flurry of takeover activity.

RPC makes plastic products in “all five major conversion processes,” the company says in its annual report: injection molding, blow molding, thermoforming, rotational molding and blown film extrusion.

Acquiring RPC would bring another 24,000 employees to Berry, which now employs about 23,000, according to its website. Berry has more than 130 locations, mostly in North America. The company has been expanding beyond that traditional territorial stronghold in recent years and now has several locations in Europe, Asia and South America. Berry is a powerhouse in plastics processing in North America, ranked at No. 1 for film and sheet in PN’s latest ranking for the region. It is in the top 10 for both injection molding and thermoforming according to PN’s ranking and lands at No. 11 for blow molding. There is a question of whether Berry would want to take on even more debt to acquire RPC.

Uncertainty has been surrounding RPC for months now as two private equity funds initially showed interest in the firm. Both Apollo and Bain Capital started considering their options last fall, with RPC eventually ruling out Bain while still engaging Apollo late last year. RPC extended the deadline for Apollo to make an offer four separate times as the two sides talked. Interest in RPC started to simmer after Chairman Jamie Pike revealed last summer the company was under pressure by investors to make changes.

Berry is being advised by both Goldman Sachs and Wells Fargo Securities in determining whether it will make a run at RPC. The company now finds itself in a position of potentially making a rival bid against Apollo, which previously owned Berry.

Tech II Developing Thermoformed In-mold PET and PP Labeling

By Roger Renstrom, Plastics News

February 4, 2019 — Tech II Inc. is pursuing research and development for the thermoforming of in-mold labels of PET and, separately, thermoforming of expanded polypropylene, said Eric Shiffer, CEO of the Springfield, Ohio-based firm.

Other R&D initiatives for Tech II involve the potential uses of injection compression, plasma-enhanced chemical vapor deposition, biodegradable packaging and radio-frequency-identification technology.

A retail shopper who reacts within two-tenths of a second can make a “first reach” if “something on a shelf grabs your attention,” Shiffer said in remarks at the IMDA symposium. The shape and graphics of a package need to align with the consumer’s preconception.

Family-owned Tech II has built its reputation as a major thermoformer of in-mold labels while continuing with its legacy involvement with the injection molding process.

In 2011, Tech II procured four machines from Thermoforming Systems LLC of Union Gap, Wash., near
Yakima. Davis-Standard LLC acquired TSL in November.

Subsequently, Tech II has worked with that equipment on 18 commercial products, Shiffer said.

For IML work, thermoforming requires less capital investment than injection molding, he noted. Further, thermoforming is faster to commercialization, has injection molding quality, offers IML-quality graphics and performs better for the high-pressure-pasteurization filling process.

Variable-height tools allow for quick change of injector bottoms.

“It is easier to change package sizes,” he said.

Shiffer said Tech II competes globally for thermoforming IML business with RPC Superfos A/S of Randers, Denmark, and an operation in eastern Russia.

Tech II had 2018 sales of $40 million, employs more than 300 and occupies 500,000 square feet in two facilities in Springfield, and, less than 4 miles away, in Urbana. The injection molding side operates 40 presses of 110-600 tons.

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Coexpan Buys Chile-based Thermoformer

By Bill Bregar, Plastics News

February 7, 2019 — Coexpan, the rigid sheet and thermoformed products division of Madrid-based packaging company Grupo Lantero, has purchased the thermoforming operations of BO Packaging of Santiago, Chile.

BO Packaging will retain its flexible packaging and poly-coated paper operations in Brazil and Peru.

Coexpan’s Chilean subsidiary, Coexpan Coembal Chile, bought the thermoforming business. Terms were not disclosed.

Coexpan officials said the deal allows the company to maintain its position as a leading player in packaging for the food industry while running three plants, with locations in Chile, Brazil and Mexico. The company extrudes and thermoforms packaging from polystyrene, polypropylene, PET and polylactic acid.

Coexpan Coembal’s plant in Chile manufactures products for fresh foods, dairy products, personal care, household products and other markets.

Companywide, Coexpan runs 13 plants in eight countries: Spain, France, Germany, Italy, Russia, Chile, Brazil and Mexico. Coexpan has annual sales of more than 350 million euros ($397 million). Major markets are food and industrial packaging.

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Understanding Electronics Packaging

By Jimmy Shah, Impact Plastics, Hamlet, NC

With continued population growth, urbanization, and real-time global connectivity, electronics has become one of the fastest growing industries in our modern society. Constant innovation in the fields of smartphones, tablets, laptops, gaming devices, video recorders and television, increases the need for packaging material to provide safe, easy to handle, lightweight, and to keep products safe from Electro Static Discharge (ESD). North America is the headquarters for some of the leading consumer electronics markets. Products that were previously designed and assembled in North America but manufactured in Asia, are now returning to North America for production as a result of increasing labor costs in Asia. It is very important that part shipment and assembly lines for these expensive electronics are ESD safe.

What is ESD Packaging?
Let’s start with a definition of ESD. ESD is the sudden flow of electricity between two electrically-charged objects caused by contact, an electrical short, or dielectric breakdown. A buildup of static electricity can be caused by tribocharging or by electrostatic induction. So, what if a minor electric current (electrons) passes through our body to the electric part? What harm could that cause?

If we think a minor static electric current cannot be harmful then we are wrong. To put this into perspective, a static ESD of as low as 25 volts can damage a microelectronic part, whereas the static generated through ESD can be as high as 20,000 to 45,000 volts under certain conditions (material type, humidity, contact type, etc.). These major charges not only damage the electric part but can also damage the internal components by altering or erasing the data. In more extreme cases, these charges can also lead to fire or explosion when introduced to flammable liquids or gases in locations such as hospitals or gas stations.

Options for ESD Packaging
ESD packaging, or ESD packaging material, is material used to reduce the buildup of static electricity under certain or all conditions when used for highly sensitive electrical parts. There are three types of ESD packaging materials classified by how quickly electrons move through the material: antistatic material, dissipative material, and conductive material.

Antistatic Material: Antistatic material is used to prevent the buildup of static electricity caused by tribocharging. Antistatic material is the least expensive form of ESD material and is the most widely used ESD material not only in electrical applications, but also for cosmetics and food packaging applications to preserve aesthetics and keep away dust. Antistatic material resistivity generally ranges between 1010 and 1012 ohms per square and initial electrostatic charges are suppressed.

Dissipative Material: Dissipative material is used for the protection of sensitive electrical parts where material directs and reduces the flow of electricity in a more slow and controlled manner. Dissipative material is the most ideal packaging material in the ESD range. Static dissipative resistivity generally ranges between 106 and 1012 ohms per square and possess low or no initial charges. This material prevents discharge to and from human contact.

Conductive Material: Conductive material is the material with the least electrical resistance where electrons can flow easily across the surface or through the material and pass on to the ground or to another conductive object that is in contact with the material. Both dissipative and conductive material are referred to as antistatic material in the industry. Conductive material resistivity generally ranges between $10^3$ and $10^6$ ohms per square with no initial charges providing the path for charge to bleed off. Conductive plastics material is used in packaging applications such as electronics packaging and storage, aerospace components, medical device, automotive and consumer electronics. Some of the benefits of conductive material include: 1) light weight with up to 50% saving in weight compared to metals or painted/coated with surfactants, 2) ease of handling, storage, and transport, 3) low cost, 4) easy processability, and 5) reusability.

Carbon Black and Processability
Most plastic is insulative in nature so how is it made electrically conductive? There are two ways to make the plastic material conductive: 1) through the use of a carbon-based additive (carbon black, carbon nanotubes, graphene, etc., and 2) a metal-based additive (copper,
nickel, stainless steel, silver, etc.) Depending on the conductivity and mechanical properties either one or a combination of both can be used in designing an ESD conductive material.

Metals are naturally conductive and increase the density of the material when compounded. Thus, carbon black is the most widely used filler to make an electrically conductive polymer. Carbon black is inexpensive and formed by burning hydrocarbons in a limited oxygen environment leaving fine residual carbon particles behind. All carbon blacks are conductive, but it is very important to understand the dispersion of carbon black in the compound and its percolation threshold with adequate volumetric loading. Depending on how the carbon black was formed and dispersed, it gives flexibility to the compounder to meet its cost vs. performance needs where sometimes lower carbon black content can lead to high electrical conductivity and vice versa. At the same time, it also affects the mechanical properties (tensile and impact properties) of the material. Compounding carbon black and later converting the pellets as a conductive compound or masterbatch to various thermoplastic resins requires a significant amount of shear for proper dispersion. Shear and residence time of the compounding can increase the electrical conductivity as a result of improved dispersion. However, eventually a “conductivity plateau” is reached and continued mixing can work negatively and reduce the electrical conductivity. Not only does it affect the electrical conductivity but it also affects the surface properties (surface roughness, surface defect) and to some extent the mechanical properties.

Resistivity Test Methods
There are two resistivity test methods used to measure the ESD properties of the material: surface resistivity and volume resistivity.

Surface Resistivity: surface resistivity is the most common ESD measurement of a material and it is used for all materials that are intended to dissipate electrostatic charges. The surface resistance is measured using two heavily loaded electrodes with an ohm meter connected in between two electrodes of the surface material being tested. It is very important to keep the testing material on an insulative table or floor to avoid any variance. The material needs to have good contact with the electrodes that are placed at a set distance as per ASTM D257 standards. Surface resistivity is measured in ohms/square. Volume Resistivity: Volume resistivity is mostly used for conductive material to check the dispersion of conductive compound through the polymer. Volume resistivity is tested in a similar fashion to surface resistivity, however, electrodes are placed on opposite faces of a test sample to check on the conductivity as per ASTM D257 standards. Volume Resistivity is measured in ohms-cm.

Thin Gauge ESD Packaging Material for Thermoforming
Innovation in thermoplastic materials with high mechanical properties, combined with carbon black masterbatch with improved electrical conductivity at lower loading rates, is moving brand owners towards thin-gauge thermoformed material for their ESD packaging needs. There exist state-of-the-art extrusion lines especially for thin gauge applications that can produce thin-gauge conductive sheet for use in the most challenging ESD applications for electrical, medical, automotive, and aerospace components. A recent project for an undisclosed aerospace application required an 0.018” (18-mil) product where gauge consistency as well as electrical conductivity were critical to the success of the project. The design for this custom thermoforming application called for a cavity approximately the size of a ballpoint pen or half the size of a nano sim card. For such a precise thermoforming application it was important to process material that was engineered for both precision thin-gauge extrusion as well as uniform carbon dispersion and electrical conductivity for maximum ESD protection. This was achieved through the use of a real-time online gauge monitoring device and offline surface resistance test meter.

To design the packaging material, it is very important to understand the final end-use application. Factors such as material cost, storage and environmental conditions (humidity), product ESD sensitivity, shelf life, aesthetics, primary or secondary packaging, type of packaging (disposable or reusable) and testing conditions can all affect the product. Impact Plastics evaluates the packaging needs of each application to formulate a custom ESD protective packaging material that will keep electrical parts safe be it temporary or permanent. Our conductive HIPS, ABS, and PP provide excellent shielding properties along with all the mechanical and physical properties of the base material itself including stiffness, dimensional stability and high impact strength.
Jimmy Shah is an Extrusion Process Engineer and Food Safety Team Leader at Impact Plastics, Hamlet, NC. Jimmy has a Master’s of Science in Plastics Engineering from the University of Massachusetts Lowell.

Impact Plastics is a custom sheet extrusion company specializing in the production of high efficiency, tight tolerance, thin gauge extruded sheet and roll stock for thermoforming applications in the food & foodservice, medical, automotive, cosmetics and electronics markets. With manufacturing locations in Connecticut and North Carolina, Impact Plastics produces custom engineered formulations of ABS, HDPE, HIPS, PP and TPO designed specifically to meet customer needs. Impact Plastics’ manufacturing facilities are in conformity with ISO 9001:2015 and FSSC 22000 V4.1 Food Packaging Material Manufacturing (NC facility.) For more information on our products and services visit www.impactplastics-ct.com.

2. ibid
3. ibid
4. ibid

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There is no substitute for the experience we’ve gained by rolling up our sleeves and working through improvements at every stage of thermoforming technology for over six decades. From process design through putting high-output machinery on the floor, innovation is in our DNA.
Analysis of Thermoformed Products

Written in Cooperation with Manfred Reichert, Remshalden, Germany

[Editor’s note: the following article is adapted from Advanced Thermoforming by Sven Engelmann Dipl.-Ing., Director of Packaging Technology at Illig in Heilbronn, Germany. Mr. Engelmann has a distinguished career in polymer science and thermoforming technology. Prior to his return to Illig, Mr. Engelmann was a Director of R&D at EBB Microparts and the Director of Polymer Technology at Gerhard Schubert GmbH, a leading designer and manufacturer of innovative form/fill/seal technologies. In addition to his work in the private sector, he is a lecturer at the University of Stuttgart and the Aalen University of Applied Sciences where he teaches “Basics of Thermoforming.” He is the author of numerous articles published in both the US and Europe on thermoforming, polymer processing and injection molding. His book, published by Wiley, will be issued as a second edition later this year. He can be contacted at sven.engelmann@illig.de.]

The preceding chapters described the analyses used by the industry to test thermoforming films as well as appropriate means of measuring thickness, shrinkage, gloss level, DSC, DMA, among other factors considered. Subsequently an issue of importance is how all these factors contribute to the thermoformed results. Namely we address in this chapter the possibilities of testing the produced containers, primarily empty containers.

The characteristics of concern are as follows:

- Wall thickness distribution
- Top load
- Visual appearance
- Water vapor permeability
- Oxygen permeability
- Transparency

Additionally described will be the main features of a testing device prepared for the practical assessment of the thermoformability by Fraunhofer Anwendungszentrum AVV, Dresden.

The above-mentioned qualities of a container created by thermoforming are also important as to how far container qualities deviate from the tolerance ranges within a multicavity matrix. A container’s quality must also remain constant during a working cycle, for example, if the production is for 60 cups per working cycle.

### 24.1 Wall Thickness Distribution

Normally the exact positions of the measuring points for measuring the wall thickness distribution are at the container walls, often at the angles. If additionally necessary by the geometry of the containers, measurements are taken at the each container’s base.

#### 24.1.1 Examples of Measuring Wall Thickness of Cups

The exact positions of the measuring points (x, y, z) are often indicated by the customer (see Figure 24.1). The (measuring) points at the cup wall and at the angle are measured four times at the circumference of the cups—each case with a 90° offset. The customer indicates the minimum wall thickness for the particular measuring points that must be maintained—with a confidence level—for all the cups of one multicavity matrix.

The measured values will have a certain tolerance range due to processing differences, and they will alternate around an average value. For example, if the required
minimum thickness at the middle of the wall is 300 μm, this means that when the results are statistically evaluated, the average values must be within the tolerance range $3\sigma$ above 300 μm.

In more simplified terms, the background is as follows: The products that the customer must fill into the cups may be sensitive to oxygen and water vapor. For this reason films with so-called barrier layers are used for thermoforming. The multiple layer films then should have a barrier layers against oxygen and water vapor. For thermoforming—from the flat basic film to the fabricated container—the wall thickness of the finished container is inevitably smaller than the thickness of the basic film. The thickness reduction of the barrier layer is disproportionately greater than the reduction of the other film layers, particularly at the corners of the containers. If the barrier layer of the container shows areas that are too thin, the products’ shelf life will be curtailed or the product will deteriorate. So verification of the container quality by means of the wall thickness measuring must be done with exact measuring of the individual layers—including the barrier layer—at critical areas of the container (e.g., at the corners). This is carried out with so-called microtome cuts. (see Figures 24.2 to 24.5)

If the quality of the cups does not meet the expectations of the customer, an optimisation may need to be carried out of the working process. The attempt to compensate poor wall thickness distribution just by increasing the thickness of the basic solution is not the best solution. Nondestructive wall thickness measurements are carried out by means of a thickness measuring gauge. A magnetic-inductive measuring method is offered, for example, by Panametrics (called “Magna Mike 800”). First, the measuring points are marked on the cups by means of a template. A measuring ball with a defined diameter is then introduced into the interior of the cup; subsequently, a measuring sensor is applied to the defined measuring points from the outside. The measuring sensor draws the measuring ball to the defined point. The measuring values
are recorded by a pedal-operated switch.

24.2 Top Load
The stability, respectively the solidity, of the thermoformed container is determined by a top load test. This test provides information regarding the further treatment to improve the load-bearing capacity of the cups. For example, this test helps determine the pressure of yogurt cups when stacked one above the other in several layers.

The container stability is closely connected to the wall thickness distribution of the container. In each case both the required top load and the related wall thickness distribution must be optimized by an adequate choice of thermoforming films and an optimal setting of the thermoforming parameters.

For the top load values the same principle applies as for the values of the wall thickness: the measured top load values must—with a confidence interval level—be higher than the demanded minimal top load values, namely the statistically determined range; the average value of bearing pressure from the measuring and standard deviation 3σ must be higher than the required minimum value. Also, due to process-related reasons, the measured top load values will have a certain variation, respectively tolerance, comparable to the values of the wall thickness distribution. This is the case for the multitude of measurements both at a particular cavity and the cavities of the whole matrix.

Simplified, the top load measurement is conducted as follows: The empty containers are introduced into a suitable test equipment with the opening pointing downward. A plate that is coupled with a pressure cell moves down from above with a defined speed onto the containers, which are compressed. The force of the container is measured and recorded. As the container buckles for the first time, the bearing pressure measuring is finished. The top load then equals the maximum force value. The measuring principle is illustrated in Figure 24.6.

24.3 Visual Appearance
For evaluation of the visual appearance of the formed container, the following points are of particular relevance:

- Is the definition of the form completely finished everywhere? Critical points are sharp edges or corners.
- Is the container’s shape otherwise okay? Unintentional free shrinkage of the container volume can occur in containers made of polypropylene, which can happen when the cooling during the forming process was insufficient.
- Are there chill marks (visible as flowmarks, etc.) on the inside of the container? This can occur when a wrong plug-assist material has been chosen, namely when a wrong plug-assist geometry has been used. However, chill marks can also be caused by wrong temperatures used in the heating of the film. Chill marks can particularly be obvious in transparent containers.

24.4 Water Vapor Permeability
Food is generally less sensitive to water vapor than to oxygen. For this reason the requirements concerning water vapor proof packaging—extreme cases excluded—are not so high for food with a moderate sensitivity and/or shorter storage time; packaging with only tightly folded closures can be used.

Normally, water vapor permeability is specified as g × 100 μm/m². DIN 53122 standardizes the conditions for measuring the permeability of water vapor through packaging material. In this connection 23°C, 85–0% r.F., and 38°C, 90–0% r.F. are preferred.

A machine manufactured by the company Mocon in Elk River, Minnesota, can be used for measuring the water vapor permeability (PERMATRAN-W 3/31). This machine uses a special infrared sensor to detect water vapor permeability of flat films and completely formed packages.
24.5 Oxygen Permeability

The gas permeability of films, namely oxygen permeability, is the most important kind of permeation. The gas permeability is measured according to DIN 53380.

A measuring instrument OX-TRAN 2/20 produced by the Mocon Company is an example of a device that can be used to measure oxygen permeability. With this device, flat films as well as formed packages can be tested. A special sensor is utilized for the test. The flat pre-cut film parts are clamped to a diffusion cell that is subsequently cleaned from residual oxygen traces by an oxygen-free carrier gas. The carrier gas is directed to the sensor until a stable zero value is reached. Then pure oxygen is passed to the outside of the diffusion cell. Any oxygen molecules that diffuse through the film to the inner chamber are transported to the sensor by the carrier gas.

24.6 Transparency

On their distribution channel, food packages are often exposed to natural light. The danger of damage to food from light exposure has risen in recent years because often the wall thickness of semitransparent packages (e.g., plastic cups) is reduced for ecological reasons.

A measure for the quantity of light that permeates packaging material is haze. For semitransparent packages a part of the light is remitted and another part is absorbed—besides the portion of the light that goes through the material. The measured values are thus represented as:

- percentages of light transmission, subject to the thickness of the packaging material,
- or as remission (reflection).

UV-absorbing filter additives can be added to the packaging materials.


Improved Gas Barrier Simulations for Food Packaging

By Irene Helland
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Norner’s barrier calculator has become a popular tool among professionals in the packaging industry. We have now made major upgrades of the calculation possibilities.

Barrier properties of packaging materials are important requirements to consider when selecting and developing optimal packaging systems. Packaging materials could prevent ingress of oxygen and/or moisture, they could keep desired balance of oxygen and carbon dioxide (CO₂) and they could prevent loss or ingress of flavours and solvents.

Our web based calculator for barrier properties was developed by a team of Norner experts and is a tool for making simulations in the packaging design phase. By using this calculator, the developer can investigate changes in design and layer structures without expensive testing in a screening phase. It will also be possible to reduce instrumented testing of permeability and actual testing of shelf life in the development phase.

The simulation model estimates the oxygen transmission rate (OTR) and water vapour transmission rate (WVTR) of packages by most plastic materials like PE, PP, PET, PA and EVOH. Barrier properties of co-injection or co-extruded multilayer and in-mould-label solutions can be studied and evaluated for cups, bottles, films and square containers.

The flexibility of geometrical options, permeability properties and environmental conditions provides a useful tool for design, development and application of plastic packaging.

The shelf life of a food product is the period between the manufacture and the retail purchase, during which time the product is of satisfactory quality in terms of nutritional value, flavour, texture, appearance and safety. The shelf life of a food product is depending on the “activity” of the product, the environment in the value chain and distribution, especially the temperature as well as the properties of the packaging system, especially the permeability.

New Features
Norner has now upgraded this web based calculator with CO₂ transmission rate calculators. Two new models have been developed for calculation; one is for a constant CO₂
concentration on one side and the other is for a declining \( \text{CO}_2 \) concentration (as in MAP).

A second upgrade is the possibility to calculate the permeability for a sequence of different conditions, i.e. a dynamic simulation of the packaging. This allows the user to simulate the variations in conditions in the value chain.

The dashboard and web interface is also redesigned and the calculators are available both in a full version, which is payable, and a free simplified version.

A wider selection of materials, unlimited number of layers for extruded films and blown articles, unlimited number of layers for cup and square boxes as well as IML and an unlimited number of conditions calculated in a sequence is available in the payable version.

**Examples**

1. **Modified Atmosphere Packaging**

Modified atmosphere is the practice of modifying the gas composition of the internal atmosphere of a package (MAP) to improve shelf life. For instance, the use of gas mixtures with relatively high levels of \( \text{CO}_2 \) can double the shelf life of raw poultry.

In this example, poultry is MAP-packed with 80% \( \text{CO}_2 \) in a thermoformed tray (20x10x5 cm) with a lidding film consisting of decorated aluminium foil. Since the logistics is cold and low permeation can be expected, a plain 100 μm PP tray was tested versus a barrier tray consisting of 40μmPE/4μmTIE/5μmPA6/3μmEVOH32/5μmPA6/4μmTIE/40μmPE. Loss of \( \text{CO}_2 \) pressure in the plain PP tray as a function of time is illustrated in the figure above.

The figure shows only a minor loss of \( \text{CO}_2 \) in the plain PP tray. For the barrier tray the loss of \( \text{CO}_2 \) is insignificant and the MAP atmosphere is constant during the 20 days we selected for these calculations. At the same time, the barrier towards oxygen was calculated using the OTR calculator. The results show that the plain PP tray has total transmission of 30 ml versus 0.13 ml for the barrier tray.

The balance of MAP gases and oxygen transmission is the key to keep the food fresh and it can be expected that the plain PP in this example is sufficient to retain the CO2/
MAP gas, but insufficient to keep the oxygen transmission sufficiently low.

2. Packed meat
The quality of meat is affected by the presence of oxygen. This effect is further influenced by temperature and temperature is known to vary through the logistic chain from producer via retailer to consumer.

This example describes a logistic chain comprising storage at producer, transportation to retailer, storage at retailer, transportation to consumer and storage at consumer. We have assumed that temperatures alter between 4 and 20°C. An oxygen limit of 1 ml is further defined. It is interesting to compare the barrier performance of a multilayer and a monolayer film.

We have defined a costly a but common 7-layer PE/PA/EVOH film structure with the following composition; [40μmPE/4μmTIE/5μmPA6/3μmEVOH32/5μmPA6/4μmTIE/40μmPE].

As a cheaper alternative solution, a thermoformed monolayer PET tray, 200 microns, is defined. The oxygen transmissions during the logistic chain over a period of 22 days is calculated and given in the figures below.

These examples illustrate that an acceptable shelf life for the defined oxygen limit is achieved for the 7-layer PE/PA/EVOH film structure, while for the monolayer thermoformed PET is insufficient since the oxygen limit is reached already at the producer.
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Further information about this event may be obtained from Yetty Pauwels at Society of Plastics Engineers, Thermoforming Europe Division Tel. +32 3 541 77 55, spe.etd@skynet.be www.e-t-d.org
Advanced Extrusion, Inc. Launches NatureGrade™ CPLA, a New BPI Certified “Component Compostable” Product Engineered to Address the Requirements of the Frozen Microwavable Food Market

By Wayne Voigtschild, Advanced Extrusion, Inc., Rogers, MN

The global frozen ready meal market exceeded $200 billion in 2018, according to Grand View Research, with projected CAGR of 2.9% through 2020. Convenience, cost effectiveness, easy storage, and reduced preparation and clean-up times are all factors that benefit busy families. Another recent study by Sheffield Hallam University (UK) found that frozen food generates almost 50% less waste when compared to fresh foods consumed in the home. These factors, in addition to the improving quality of frozen meals, explains the rising demand for ready-to-eat foods among today’s consumers, a trend that is expected to continue well into the future.

The use of plastic products to support this increase in frozen ready meals has increased significantly because of their low cost and functional advantages over traditional materials. Some of these advantages include thermosealability, microwavability, optical properties, and the ability to manufacture unlimited sizes and shapes. Plastic does the job of getting product through the supply chain to the consumer with minimal loss and waste. Yet our industry is well-aware that only 9% of plastic produced is recycled with the remainder ending up in landfills or the waste stream as pollution.

The Changing Landscape

Some of the aspects that influence packaging materials and designs are unchangeable, like the need to safeguard its contents. Other influences are purely aesthetic, like color or shape. However, when it comes to sustainability, industry leaders report there is increased demand for more efficiencies in all aspects of the supply chain. It begins with consumers caring about environmental issues more than ever before and spending their dollars to reward companies that share their values. According to a new study published by Nielsen and The Conference Board, 81% of consumers globally feel that it is “extremely important” or “very important” that businesses implement programs to improve the environment.

As a producer of packaging material, Advanced Extrusion is working aggressively on the creation of sustainable plastics that do the same job as PET or polypropylene with less material, and at competitive cost. For converters, this new sustainable plastic reduces our carbon footprint, boosts energy efficiency in production, and reduces waste the industry generates and sends to landfills.

NatureGrade™ CPLA - Performance with Environmental Consciousness

When PLA was first introduced to the packaging industry, it had several limitations that prevented it from being considered in the frozen ready meal market. Specifically, it fell short of PET and polypropylene in several critical areas including heat resistance, density, and as a barrier against oxygen and other gasses. They recognized that if these
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problems were overcome, the use of a PLA-based plastic as an alternative plastic would environmentally out-perform every petroleum-based plastic in the industry. It was a goal worth pursuing.

Advanced Extrusion launched an intensive research and development effort to address the shortcomings of PLA in a new product branded NatureGrade™ CPLA. This new product was engineered to dramatically expand its temperature range to accommodate temperatures from -10°F to +250°F, rendering it suitable for the frozen ready meal market segment. Furthermore, the density (or specific gravity) of NatureGrade™ CPLA is 1.25 g/cm³ vs. PET at 1.35 g/cm³, which translates into more piece-parts per given weight of material. NatureGrade™ also has a higher modulus than polypropylene allowing it to be down-gauged up to 30% to create the same parts with less material. These characteristics combine to make NatureGrade™ CPLA competitive with PET and PP when thermoforming parts. The final challenge to make this product suitable for the frozen ready meal market required the creation of an integral oxygen barrier that provides protection against harmful contaminants entering the package. To accomplish this, they incorporated an oxygen barrier into the product that reduces the oxygen transfer to 0.01cc/m² · day at 1 atm of pressure when tested at 50% relative humidity and 23°C. This compares very favorably to the barrier properties of EVOH which has a transfer rate of 0.16cc/m² · day at 1 atm of pressure.

Addressing Market Demand for Sustainable Packaging

NatureGrade™ CPLA is one of the most sustainable packaging products available today for the frozen ready meal market. This engineered plastic is derived from annually renewable resources and is primed to make significant contributions that address the reduction of greenhouse gases, landfill shortages, and carbon footprint. Consumer research validates that consumers expect packaging to protect and preserve the product, assuring safe, secure delivery. But with growing environmental concerns, consumers also want packaging that is recyclable/compostable, and space-efficient, helping to shrink the overall carbon footprint of the brand. NatureGrade™ CPLA helps to reduce

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<th>Comparative Properties of NatureGrade™ CPLA vs. Polypropylene</th>
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the amount of plastic material required per package, representing a step in the right direction toward meeting consumer needs for space efficiency. Equally important, NatureGrade™ CPLA with oxygen barrier is certified by the Biodegradable Products Institute as being “component Composable.” This certification simplifies and accelerates a thermoformer’s ability to receive a BPI certification on formed products made from NatureGrade™ CPLA. Standard colors include light brown, dark brown, white, dark green, black and beige. Additional colors are available upon request.

**NatureGrade™ CPLA Product Characteristics and Specifications**

NatureGrade™ CPLA is poised to make significant progress on an environmentally friendly innovation that meets consumer demand for a more sustainable society:

- Retains strength and shape when heated to 250°F in oven or microwave
- Remains strong without becoming fragile when frozen to -10°F
- Highly effective oxygen barrier assures contaminants do not enter the sealed package
- More energy efficient, requiring less heat than PET to form
- Lower density equates to more parts per given weight of material
- Higher modulus allows down-gauging up to 30% to reduce the amount of material per part
- Incorporates a unique nucleating agent to promote accelerated crystallization during the thermoforming process
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- All components within NatureGrade™ CPLA are lawful under U.S. Food and Drug Administration 21 CRF 177.1630, along with Europe raw material 1935/200/EEC and Regulation 10/211

For more information, visit www.advancedextrusion.com.

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If you or someone you know is working towards a career in the plastic industry, let the SPE Thermoforming Division help support those education goals.

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THERMOFORMER OF THE YEAR

The Awards Committee is now accepting nominations for the next THERMOFORMER OF THE YEAR. Please help us identify worthy candidates. The deadline for submitting nominations is March 31, 2019.

This prestigious honor will be awarded to a member of the industry who has made a significant contribution to the thermoforming industry in a technical, educational, or managerial aspect of thermoforming. Nominees will be evaluated and voted on by the SPE Thermoforming Division Board of Directors during the Spring Board Meeting.

Please complete the form below and include all biographical information. The total submission, including this application page, must not exceed four (4) pages.

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- Nominee’s Education (include degrees, year granted, name and location of university)
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- Professional honors and awards.
- Publications and patents (please attach list).
- Evaluation of the effect of this individual’s achievement on technology and progress of the plastics industry. (To support nomination, attach substantial documentation of these achievements.)
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ALL NOMINATIONS MUST BE SIGNED. Please submit nominations to:

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