by Claire Koelsch Sand

Multilayer Packaging Continues to Make Its Mark

Multilayer packaging encompasses the use of multiple materials that intimately link to form a package structure. Most food packaging is multilayer. Layers are often plainly seen, such as in the laminated layers of polymers, paperboard, and aluminum in TetraPak classic brick-shaped cartons. Other layers, however, are less evident, such as the thin layers coextruded within polymer films and coatings applied onto paperboard cartons. Layered food packaging protects food in a specific manner, improves brand operations, decreases distribution damage, enables retail presentation, aligns with consumer use, and minimizes package materials.

Specific Food Protection

For food packaging, barrier layers within packaging add shelf life with refined and specific oxygen, aroma, and flavor barrier properties. Common barrier layers are ethylene vinyl alcohol (EVOH), metallized films, and aluminum foil. Due to its exceptional chemical resistance and oxygen barrier properties, EVOH is commonly layered with polyethylene (PE) and polypropylene (PP) and used within laminate structures. Interestingly, EVOH is water-sensitive; the layers of PE and PP protect EVOH from water, and PE provides an excellent sealability.

The barrier properties of EVOH can be leveraged throughout the entire food distribution chain. In retail packaging, EVOH is ubiquitous in the packaging of meat, cheese, and snacks, including potato chips, roasted nuts, and beef jerky. EVOH layers are also used in foodservice (hotel, restaurant, and institutional) packaging, and in intermediate and bulk packaging formats as well. For example, following pasteurization, tomato puree used by pizza parlors is packaged in 1,000 L flexible, intermediate bulk containers. The product can be later packed in smaller 3 kg, 5 kg, or 7 kg packs, also with EVOH, for safe transportation. The concept of intermediate-sized containers has also been used to package coffee beans, rice, nuts, seeds, and powdered milk in 25 kg–75 kg formats, commonly referred to as "hermetic bags." The benefit of food preservation has also been commercialized in liners of shipping containers, or "flexitanks," with a capacity range of 8,000–36,000 L for the transcontinental shipment of various commodities, including olive oil, concentrated juice, and wine. In the case of wine flexitanks, "EVOH layering has shown to be effective in minimizing the ingress of organic solvents, haloanisoles, and naphthalene, commonly found as tainting-compounds of wine," says Edgard Chow, technical service development director of EVAL at Kuraray America Inc.

Kuraray's application development lab *assesses the layering compatibility of EVOH.* Photo courtesy of Kuraray

EVOH layering is very product- and application-specific. "We can rapidly adjust resins to meet product-specific needs using our applications development lab and our refined resin capability," says Chow. "The oxygen barrier of EVOH is inversely proportional to its ethylene content. For example, a 27 mol% ethylene EVOH offers higher barrier (lower permeability) than a 48 mol% ethylene EVOH. The selection of the grade depends on various factors including food sensitivity, food processing technique, packaging format, package surface area, net content, storage conditions, and target shelf life." He added that "beyond providing an oxygen barrier, EVOH prevents the deterioration of food by preserving vitamin C, preventing the loss of flavor and aroma, and containing flush gases used in modified atmosphere packaging. Additionally, EVOH prevents the ingress of off-odors and off-flavors from other foods while the packaged food is transported or stored in warehouses, supermarket shelves, or food pantries at home." In emerging markets such as Latin America, these properties have allowed brand owners to streamline packaging by using EVOH in flexible pouches to replace aluminum foil in aseptic UHT milk cartons and in tomato sauce standup pouches.

Improved Brand Operations

The filling of food into packaging demands a high filling speed and then sealing operational integrity. In vertical form-fill-seal-machines, the packaging material is formed into a sealed tube, sealed on the fin (back) seal as the product is filled, and then sealed on the other end. Speeds can exceed 150 packages per minute. This high-speed operation requires packaging material of high tensile strength and low percentage elongation to avoid excessive stretching when pulled from a flat sheet around the machine former to make the tube. High-speed sealing requires high-temperature resistance, hot tack, and elastomers to flow rapidly within the seal area. One material cannot match all these requirements. In addition to printed inks, a direct food contact and seal layer comprised of PE and elastomers is typical. Often a thin layer of EVOH and a thicker nylon layer are incorporated to provide oxygen barrier and puncture resistance. Materials such as polyethylene terephthalate (PET), PE, PP, or paperboard provide the function of the main structural layers which represent the major composition of the packaging.

Often, PET provides the high-temperature resistance needed for many sealing operations. For operations such as those for more extensive produce packaging, such as for 3 lb mesh bags of limes, requirements are different. In this case, the mesh is made of mostly PP and PE or PET with a seal layer to allow for sufficient tensile strength, burst strength, cold-temperature tear resistance, and seal strength.

Decreased Distribution Damage

Once filled, packaged food enters a distribution system that is often varied and unknown. Distribution testing hones package requirements.

One requirement is that the print not be scuffed and distorted as the package is transported at various conditions (temperature and relative humidity) by rail, truck, ship, or plane, and then stored and transported via tram, car, bicycle, or walking, and within shopping bags, backpacks, and cases by the consumer.

Distribution from a center such as Amazon, in which numerous combinations of packaged foods are shipped together, presents another complex array of requirements. Print scuffing is especially relevant to the food industry because consumers need to read nutritional information, allergen alerts, and product use instructions. Retailers and distribution centers need to scan QR and bar codes for tracking and at consumer purchase. Scuff-resistant layers that inhibit ink abrasion include PE and matte finishes, placed onto polymer, paperboard, glass, or metal.

Interestingly, PE and titanium dioxide are standard coatings applied to the surface of glass containers to inhibit distribution scuffing, which can weaken the glass. These and other coatings allow for glass containers to be shipped without corrugated dividers between the containers. When dividers are removed, trays are sealed with multilayer overwraps that provide shrinkability, sealing capability, and puncture resistance. Other distribution situations, such as top load associated with static storage needs, and shock and vibration, which are associated with dynamic shipping environments, require multilayer packaging to provide burst-, puncture-, and tear-resistance.

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The multilayer **Ecolean Air Aseptic Clear** *is recyclable.*
Photo courtesy of EcoLean

Assist Retail Presentation

Although grocery stores, convenience stores, and club stores vary in format, packaging can reduce labor by enabling rapid shelf stocking, retaining stacking capability, and optimizing shelf space in all these formats. This requires packaging with the ability to "stand up tall" on the shelf. In the soy, oat, and almond milk category, the use of different materials and package design with Finite Element Analysis allow for stackability. For example, the clear *Ecolean Air* package employs an air-filled handle to add a supportive structure to its aseptically processed milk pitcher-shaped pouch. In the Ecolean pouch, a thin layer of EVOH is used to prevent oxygen ingress, and two or more additional layers enable sealing and direct contact with ultra-high temperature processed milk. Likewise, the TetraPak multilayer aseptically filled brick-shaped design comprised of PE, paperboard, and aluminum uses paperboard as the supportive layer and a thin layer of aluminum for the barrier, with other polymers for layer seal strength and scuff resistance.

Tetra Classic Aseptic Slim single-serve multilayer pouches have the same degree of rigidity, although they lack the design for

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stackability. Notably, milk in multilayer pouches lacks a paperboard layer but has a seal and a water and oxygen barrier layer. This requires retail structures such as boxes or cubes to contain the pouches. These cubes are also used for shipping. Paperboard cartons coated on the inside and outside with moisture-resistant layers also meet retail needs for stackability thanks to the paperboard fiber strength and the cube-shaped design. Other retail needs, such as pilfer-proof packaging and moisture resistance also require multilayer packaging.

Align With Consumer Use

To ensure product freshness, consumers need to be able to open and reclose food packages. This often demands multilayer packaging. For example, cheese-slice trays with peel and reseal lidding are comprised of oriented reverse-printed PET, EVOH, and a peel and reseal layer. The oriented PET provides a highly printable surface while the EVOH provides the additional oxygen barrier and the peel and reseal layer keeps food fresh and allows for opening and closing.

Minimized Material Usage

Multilayer packaging that incorporates an oxygen barrier layer significantly reduces the thickness and weight of packaging needed to protect food vs. a packaging that lacks the oxygen barrier layer. The oxygen barrier property translates to lower packaging costs and lower environmental impact. For example, a 4 oz thermoformed PP/EVOH/PP container used to package shelf-stable diced fruit has an average of 25 microns (1 mil) of EVOH in a total sidewall of 20 mils. Alternatively, to make a container made of PP (without the EVOH layer) would require a sidewall thickness of 6,500 mils or 6.5 in, which is not viable.

How Layers Are Formed

Coating, extrusion, and lamination are used to produce multilayered packaging. The technologies for these processes have evolved considerably since the 1980s when five-layer films and blow-molded bottles were initially developed. Today, nine-layer equipment is common and as coextrusion technology continues to evolve even more layers are possible. More layers and thinner layers allow for more efficient use of materials.

Many processes are used for coatings. Thin-layer aluminum deposition is used to produce metallized films commonly used to meet oxygen and water vapor barrier needs for gas-flushed single-serve snack food packaging. Atomization is used for thin coatings such as antimicrobial layers, and thick coatings are rolled onto a package substrate. Molded-pulp produce containers such as *EarthCycle* are lined to inhibit moisture loss and gain. The coextruded layers must have compatible properties for the polymers to be extruded into layers without an adhesive or tie layer. For example, a layer of PE will stick readily to another layer of PE that has a slightly different formulation; however, a layer of PE, due to its nonpolar nature, will require a tie layer to stick to a polar layer like EVOH or nylon.

New Developments

Advanced layer deposition. More defined seal layer applications, such as those used in candy bar wrappers, allow for deposition of a cold-seal component where only the seal is needed. Atomic layer and plasma deposition techniques are advancing rapidly to control the deposition of layers more accurately and allow for more specific barrier and structural properties.

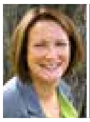
Recycle-ready multilayered packaging. Material recycling facilities demand more recycling-ready packaging, and multilayered packaging is increasingly recyclable thanks to refined package design, resin innovation, and recycling advances. Packaging with a recyclable EVOH layer is replacing nonrecyclable layered packaging.

The excellent gas barrier and ease of processing of EVOH make it an ideal material for sustainable packaging because in addition to reducing food waste, it enables the production of lightweight, cost-effective packaging that can also be recycled. Diana Maya, technical service and development engineer, at Kuraray America Inc., expands: "Most recently, Kuraray has developed a new *EVAL* series of EVOH with enhanced barrier and orientability as an alternative to polyvinylidene chloride (PVdC) in shrink bags, metallization in biaxially oriented films, and polyamide in forming webs." These technologies enable structures such as the *Ecolean Air Aseptic Clear* to be recyclable. Multilayer TetraPak cartons are recycled into composite boards, and the distinct layers—paperboard, aluminum, and polymers—comprising the cartons.

Visstun's double-wall paper coffee cup *is composed of layered paperboard containing* EnviroLife *sustainable recycled fiber, virgin pulp, and polyethylene to allow for water resistance, strength, printability, and cleanliness, and it is recyclable.* Photo courtesy of Sustana Fiber

Use of more recycled content. Multilayer structures comprising PE and EVOH have replaced PVdC in instant oatmeal packets and foil in tea leaves sachets. Interestingly, the chemical resistance of an EVOH layer is used in many areas of post-consumer packaging. For example, in the case of multilayer packaging that includes recycled paper, EVOH not only prevents oxygen from coming in but it prevents any possible hydrocarbons in the recycled fiber from migrating into the food. Furthermore, EVOH is also being used as the layer within a geomembrane inhibiting the migration of perfluoralkyl substances from landfills, restricting hydrogen sulfide gas diffusion from biodigesters, and funneling methane release from composting sites.

Thus, multilayer packaging continues to make its mark on packaging. **FT**



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