Reusing Food Packaging . . . Is It Safe?

M. Susan Brewer

University of Illinois at Urbana-Champaign
College of Agriculture
Cooperative Extension Service
Circular 1320A

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This publication was prepared by *M. Susan Brewer*, Extension Specialist, Foods and Nutrition, Division of F-
oods and Nutrition, University of Illinois at Urbana-Champaign.

Edited by Francine Weinbaum
Designed by Joan R. Zagorski

Urbana, Illinois July 1992
Issued in futherance of Cooperative Extension Work, Acts of May 6 and June 30, 1914, in cooperationwith the U.S. Department of Agriculture. DENNIS CAMPION, *Interim Director*, Cooperative Extension Service, University of Illinois at Urbana-Champaign. The Illinois Cooperative Extension Service provides equal opportunities in programs and employment.

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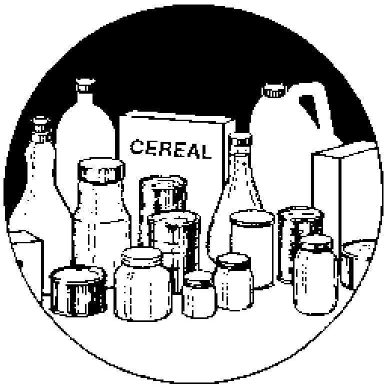
Introduction



How does our food get on the table? Packaging is an essential component in the complex distribution system which moves agricultural products from their point of origin to their point of consumption. Along with our culture, our packaging of food has become increasingly specialized and complex. Sterile boxes of fruit juice, plastic food pouches that can tolerate pressure canning, and microwave-safe containers are but a few examples of specialized food packaging which did not exist twenty years ago. Food packaging has several functions other than its primary one of protection. Packaging protects food from microbial and other environmental contaminants, and from damage during distribution. It also offers the consumer nutrition and ingredient information, cooking instructions, product weight, brand identification, and pricing.

Many consumers reuse food packaging because they are concerned with protecting the environment. Recent years have brought increased environmental pollution and decreasing natural resources and landfill space. But improper reuse of food packaging can threaten health. So it is important to follow certain guidelines (see page four). For example it is generally safe to reuse glass that has been used for food, but not to reuse plastic or paper. Understanding the uses, specialized functions, and limitations of packaging materials used for protecting consumer foods can help consumers make safe decisions regarding the reuse of packaging materials.

This circular discusses the following topics:

1. commercial sterilization techniques that keep microbes out;

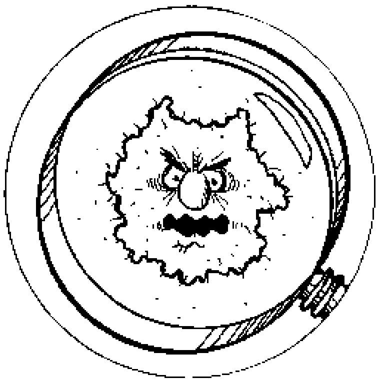
2. glass, plastic, and paperboard packaging of food;

and includes

3. easy-to-follow guidelines for reusing food-packaging materials;

4. a glossary of food-packaging terms for the consumer who wants to take the time to become knowledgeable.

Keeping Microbes Out



Establishing microbiological stability is of primary importance for most food products. Early food packaging had to be able to tolerate heat so that the product could be canned (terminally sterilized in the container). Glass and tin cans were the original processed-food packages because they could tolerate sterilization temperatures. Because food flavors are apt to change during heating, a variety of sterilization techniques have been designed to kill or remove microbes from food products using little or no heat processing. These techniques include the use of hydrogen peroxide treatments, aseptic packaging (packaging in a sterile environment), ultra-high temperature (UHT) sterilization (which uses high temperatures for very short times), and gamma ray irradiation. The packaging materials used for these new processes must be sterilized before they are used; methods used to sterilize packaging include hydrogen peroxide or steam treatments, exposure to ultraviolet light, or gamma ray irradiation. A variety of foods are "hot-filled" at 170^0F, so the chemically sterilized packaging must be able to tolerate temperatures slightly above 170^0F. Packaging materials that tolerate these processes will not always tolerate temperatures over 180^0F without substantial breakdown.

Glass Versus Plastic and Paperboard

Most packaging materials are designed for one use. With the exceptions of glass containers requiring user deposit and limited-use polycarbonate bottles, manufacturers assume that consumers will take the product home, then discard or recycle the packaging. Packaging is designed accordingly. Packages are designed to tolerate the type of food system (acid, base, alcohol, or fat) that will be contained within them. No safety is implied for other food systems or for reuse of that package in ways not suggested for the original food product. In general, glass is the only packaging material designed for reuse that uses the packaging over again in its original form. Plastic and paperboard are designed to be recycled into new packaging forms *that do not come into contact with food*. These recycled forms can be used in outer layers of a food package or as containers for foods encased in other materials.

When manufacturers design a packaging system, they consider the type of food (high-acid versus low-acid), the susceptibility of the food to light and oxygen (milk, fruit juice), the amount of physical protection needed (eggs), and the amount of product visibility desired (fresh meats). They also consider the amount of heat to be used during sterilization, the container size, and the type of "home processing" to which the product will be subjected (for example, microwaveable pizza). Other considerations include the cost and availability of the packaging material, the cost of transporting the finished product (plastic versus glass soda bottles), recyclability (plastic versus paper), and consumer attitudes about packaging.

Most plastics are considered "high-barrier" packaging materials. They exclude mosture and most gases (including oxygen)., and they can be either optically clear or opaque. Because of their unique characteristics, plastics are becoming the most important packaging material for food products. The packaging industry is the largest user of plastics; more than 90 percent of flexible packaging is made of plastics.

Plastics are produced from base polymers called "resins." Most actual packaging applications involve several types of resins. Structural polymers such as polyethylene (PE) and polypropylene (PP) provide mechanical properties (strength, rigidity, abrasion resistance) at low cost. Barrier polymers such as polyvinylidene chloride (PVDC) and ethylene vinyl alcohol (EVOH) provide protection against transfer of gases, flavors, and odors. Tie resins (adhesive resins) bond the structural and barrier resins together. Heat-seal resins provide package closures in flexible packages. In fact, many "plastic" packages are actually layers of different polymers. Each layer makes a contribution to total package performance.

Flexible plastics may contain small amounts (1 to 2 percent) of other substances that perform specialized functions. These "additives" include catalysts to aid in the polymer formation reaction, antioxidants to prevent oxidation of the packaging material, stabilizers to prevent degradation of the packaging material when it is heated or exposed to ultraviolet radiation, and plasticizers. Plasticizers increase the flexibility of plastics. They intersperse around the polymer molecules and prevent them from bonding to each other so tightly that they form a rigid substance. Plasticizers may lower the melting point of the plastic, and many have relatively low melting points themselves. There has been some concern about the migration of plasticizers out of the packaging material into the food product, a problem that can be aggravated by heat and by the presence of a food into which the plasticizing chemical will dissolve (for example, oil, acid, or alcohol). Migration of the compound increases with length of contact time and temperature, and levels of migration are highest when there is direct contact between film and foods with high fat content at the surface.

The Food and Drug Administration assesses the initial safety of packaging materials for food contact. If substances are shown to migrate from the packaging into the food, they are treated as "incidental food additives" and toxicological studies are conducted in order to establish safety standards. The safe reuse of packaging materials has been studied much less, but some generalizations can be made.

Guidelines for Reusing Food-Packaging Materials

1. Packages from products other than food *should never be used as food containers.* They have not been tested for safety with food systems, and they may contain small amounts of nonfood residues. (For example, do not use plastic laundry detergent buckets for storing dry cereal.)

2. Glass can be reused for all foods and for all processes. This is true regardless of what food was originally packaged in the glass container. There is an exception to this rule: single-use glass jars should not be used for pressure processing in the home canner. The lid or cover, however, is subject to recommendations discussed below (number 3).

3. Reuse packaging materials only with the following:

- foods similar in acidity and in sugar, fat, or alcohol content to the food originally packaged in the material. Do not use a plastic shortening container to make salad dressing containing a substantial amount of vinegar.
- foods that will be exposed to the same types of processes. Do not melt butter in the microwave oven using a plastic margarine container. In general, do not subject food packages to heat unless the instructions on the original package give heat ing information. Many food products are "hot-filled" into containers at low temperatures. These packages will not tolerate heating.

4. Do not reuse porous packaging materials such as paper, paperboard, and expanded foams (for example, styrofoam cups and foam meat trays). They have air spaces that will harbor food particles and microorganisms.

5. Do not reuse microwave packages that contain "heat susceptors" for browning or crisping. The adhesives that hold the susceptor to the package may be damaged by the original use. The material is more likely to migrate into the food if it is used again.

6. It is better not to store foods with strong odors or flavors in reused food packages; the packaging material might absorb the chemicals that produce the odor or flavor and release them into a subsequently stored product. Additionally, some packaging materials allow certain chemicals to pass through them, transferring odors or flavors to other foods stored in the same area.

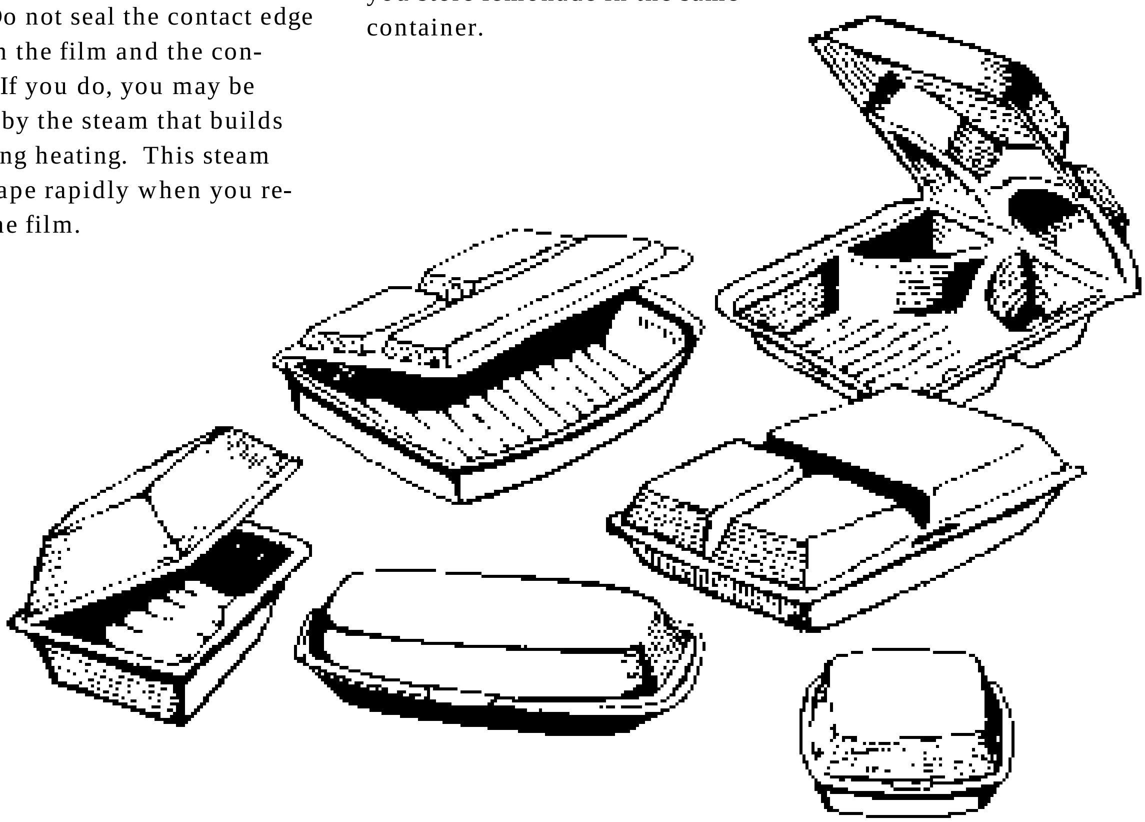
7. When materials are safe for use in the microwave oven, they are usually labeled for such use. If you do not know whether the material is safe for use in the microwave, don’t use it. Soft plastics are especially likely to flake, blister, deform, and melt. This allows plastic polymer or additives to penetrate into the food.

8. Suppose you are using a flexible plastic wrap to cover a container of food you are heating in the microwave. Be sure to “tent” the film over the food with toothpicks. There should be no direct contact between the film and the food. Do not seal the contact edge between the film and the container. If you do, you may be burned by the steam that builds up during heating. This steam can escape rapidly when you remove the film.

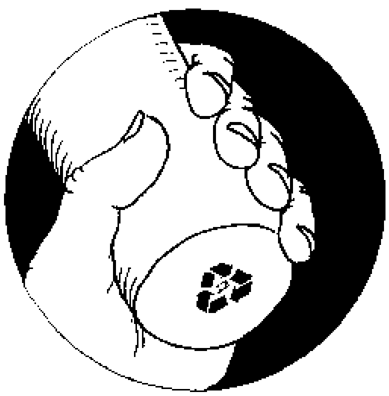
9. If you are using a flexible film bag like a bread wrapper for food storage, always use it with the printed side out. Printing inks may contain materials that are not meant for human consumption. These inks may migrate into food if they come into direct contact with it.

10. If you store a nonfood item in a food container, do not reuse the container for food storage. Many plastics pick up small amounts of the substances stored in them and release them later. Motor oil stored in plastic milk jugs will later be present in lemonade if you store lemonade in the same container.

11. Use only “food-grade paper” in direct contact with food products. Paper processing uses a variety of chemicals, and the raw materials can contain residues which would be unacceptable in foods. Paper products destined for contact with food are manufactured by processes which minimize residues, and the finished product is routinely tested.



A Glossary of Food-Packaging Terms



Food-grade plastics often have information embossed into the bottom of the container. The type of plastic material may be referred to by an acronym such as HDPE or EVOH.

ABS

Poly(acrylonitrile-butadiene-styrene) copolymer. Heat distorts it at 200^0F. Maximum continuous service temperature is 165^0F. ABS is resistant to acids, bases, fats, and oils. It does not resist solvents and yellows if exposed to sunlight. ABS has been cleared for food use with all foods *except* those containing alcohol and those subjected to thermal processing. It can be used with foods that are filled and stored at room temperature, and stored refrigerated or frozen.

ATBC

Acetyl tributyl citrate, a derivative of citric acid. ATBC is used in flexible packaging films and has been cleared for use as a plasticizer for food contact surfaces of resinous and polymeric coatings and in paper and paperboard for use with fatty foods. It has been sanctioned by the FDA and falls into the “relatively harmless” toxicity category as a consumable chemical. Estimated daily human intake from current uses of plastic film is around 0.0008 milligrams per kilogram of body weight. ATBC is considered safe at this level.

AN

Acrylonitrile monomer. Usually, the term refers to acrylonitrile that is polymerized with styrene or methyl acrylate. AN films, coatings, and semirigid containers are cleared for use only for single-use food-contact surfaces. They have not been tested for use above 120^0F. AN films are used primarily in the pharmaceutical industry.

CA

Cellulose acetate. This material is manufactured like cellophane, but there is an additional reaction that includes acetic anhydride. It is easily deformed by heat, acids, bases, and some solvents but is resistant to fats and oils. It builds up static. Maximum continuous service temperature for CA is 175^0F.

Cellophane

Regenerated cellulose-based flexible packaging material. Cellulose is dissolved in sodium hydroxide, then extruded into an acid-salt bath to produce filaments of regenerated cellulose. It can be coated with Saran for use with oily or greasy products. Cellophane was introduced in the 1920s as a bread wrap. It is semi-moisture-proof and heat-sealable. The heat-sealing range is 200 to 300^0F. Cellophane is flammable.

EVA

Ethylene-vinyl acetate copolymer. EVA is a flexible packaging material formed from low-density polyethylene (PE) and vinyl acetate. It is more flexible than PE but more permeable to water and gases. EVAs are unstable at high temperatures but stable at low temperatures. EVA is cleared for use with fatty foods and for treatment with irradiation as a sterilant (up to 8.0 megarads total), so it need not be heat-sterilized. It is very stretchy, so it can be used as a shrink wrap.

EVOH

Ethylene vinyl alcohol, a copolymer of vinyl acetate and ethylene. It may be modified by blending it with another organic polymeric phase (polystyrene or nylon). EVOH can be formed into films, sheets, and rigid containers. It provides an excellent barrier to flavors and gases (such as carbon dioxide). EVOH has excellent chemical barrier properties, so it can be used with a wide variety of foods. There are three types of EVOH:

1. An ethylene content of 55 percent to 30 percent vinyl alcohol can be used with acid aqueous and nonacid aqueous foods with no free surface oil; dairy oil in water emulsions; oil-free beverages; bakery products and dry solids with no free surface oil; and foods that are hot-filled or pasteurized at 150^0F or less, and room-temperature-, refrigerator-, or frozen-stored.

2. An ethylene content of 55 percent to 15 percent vinyl alcohol can be used with aqueous acid and nonacid foods with free surface oil; dairy oil in water emulsions; beverages; low-moisture fats and oils; moist bakery products and dry solids with free surface oil; and foods that are refrigerated or frozen-stored with no thermal treatment.

3. An ethylene content of 20 to 40 percent, to 60 to 80 per cent vinyl alcohol is approved for food use with all foods except those containing alcohol and those which are boiling-water-sterilized, hot-filled, or pasteurized above 150^0F. This material can be used on refrigerated or frozen ready-prepared foods to be reheated in the container at the time of use, provided the specific film has been tested and has been shown not to release substances exceeding 0.15 milligrams per square inch of food-contact surface at 212^0F.

FSL

Food-simulating liquids. These are substances which are used to simulate the possible reactions between food and materials with which they come into contact. The chemical characteristics of FSLs are specific, so a particular food may be simulated with several food-simulating liquids including distilled water, 3 percent acetic acids (acid foods), 8 percent or 50 percent ethanol (alcohol-containing foods), and n-heptane (fat- or oil-containing foods).

HDPE

High-density polyethylene (see PE). HDPE has a maximum continuous service temperature of 160^0F but distorts at 140^0F. It is resistant to moisture, gases, acids, bases, solvents, and fats and oils. It will build up static. HDPE is used for milk jugs, cleaning supply bottles, and trash bags.

High-oxygen-barrier polymers

Polymers used to prevent almost all oxygen transfer. These materials include vinyl alcohol, vinylidene chloride, and acrylonitrile. Pure polymers of these substances are not melt-processable, so they are made into copolymer forms such as PVDC, EVOH, or AN.

HP polyester

High-performance PET. This material has a melt point of 275^0F and can be melt-blown and hot-filled. The final container is yellow but has excellent barrier properties. For instance, it retains carbon dioxide in soda.

Hydrogen peroxide

An oxidizing agent used for cold sterilization of packaging such as films and bottles before filling them with hot or sterilized food. Residual hydrogen peroxide is limited by the FDA to 0.1 parts per million (ppm) after packaging (FDA 21CFR 178.1005). Hydrogen peroxide is permitted as a sterilant for PET, olefins, and EVA.

LDPE

Low-density polyethylene (see PE). Maximum continuous service temperature is 140^{0}F; it heat-distorts at 104^{0}F. LDPE is resistant to moisture vapor, acids, bases, and fats and oils. It has poor resistance to solvent and builds up static. LDPE is used primarily for packaging films and for bread-wrapping bags.

OPP

Oriented polypropylene. OPP has good light and oxygen barrier characteristics and protects against moisture. It is clear but will accept printing ink. OPP can be manufactured to be semirigid to flexible. It can be overlaid with metalized polyester (silver, gold, or colored). It is used for controlled atmosphere snack foods in which air has been flushed out and replaced with nitrogen to prevent development of rancid flavor. Examples of these snack food are chips in "bubble packs" and airline peanuts.

PC

Polycarbonate. PC is a rigid plastic. It is very clear and break-resistant. It is stable to acids and fats but has poor resistance to bases and solvents. It will not tolerate continuous boiling in water. Maximum continuous service temperature and heat distortion occur at 275^{0}F. This material is used for baby bottles. Recent legislation in New York allows refill (up to 100 times) of polycarbonate plastic bottles for school milk programs and half-gallon milk containers for retail use.

PE

Polyethylene. Polyethylene is cleared for food contact surfaces as an "olefin polymer." The structure of this polymer is relatively loose, so it is a less effective barrier than PVDC or PVC. It was introduced in the food industry in the 1950s. PE can be produced by two processes: low pressure produces high-density PE, while high pressure produces low-density PE. Low-density PE is strong and clear. It is a good moisture barrier but a poor oxygen barrier, and it will heat-seal to itself. PE builds up static and tends to cling to itself. Its heat-sealing range is from 250 to 350^{0}F. In general PE is cleared for use for packaging but not for cooking. Copolymers have been tested and approved for use with aqueous acid and nonacid foods containing free oil that are heat-sterilized at temperatures over 212^{0}F if the material is less than 0.02-inch thick, or hot-filled or pasteurized at 150^{0}F if the material is between 0.004- and 0.02-inch thick. PE has been cleared for irradiation sterilization up to a total of 6.0 megarads. Certain polymers have restricted uses, especially with respect to temperature.

PET

Polyethylene terephthalate, a polyester resin used for high-impact resistant containers. When melt-blown, it provides a good barrier for both flavors and hydrocarbons (fat). It is not transparent. PET is resistant to acids, bases, some solvents, and oils and fats. It is difficult to mold. PET is used for soda, mouthwash, pourable dressings, edible oils, and peanut butter. Monolayer films will hold a crease, and are heat-sealable and transparent. The film is used for cereal box liners, soda bottles, boil-in-the-bag pouches, and microwave food trays. The melting point of unmodified PET is below boiling. At boiling temperatures, bottles will shrink 30 percent and deform badly. Modified PETs have melt points of 253 to 275^{0}F. These containers are more expensive, but they can be used for hot-filled products such as juice-based beverages and tomato sauce. Heat distortion occurs at 180^{0}F; maximum continuous service temperature is 212^{0}F. High-melting PET is used for rigid trays of the type used for TV dinners or entree items. It can be heated in a microwave or in a conventional oven at 350^{0}F for 30 minutes. There has been a moderate amount of concern that additives from these trays may migrate into foods, particularly if the trays are reused in a microwave oven.

Plasticizers

Substances used to increase the flexibility of polymeric (plastic) films. They prevent formation of some of the bonds between polymer molecules and make the films less rigid. Common plasticizers include dioctyl adipate (DOA), which is used with PVC; butylated hydroxyanisol (BHA), which is used with polystyrene and styrene; low-density polyethylene (LDPE); high-density polyethylene (HDPE); and high-molecular-weight hindered phenols, which are used with ethylene-vinyl acetate (EVA). Other approved plasticizers are listed in *The Food Chemical News Guide* (pp. 328.1–328.4).

Polyamide (Nylon-6, Nylon-12)

A flexible packaging material made from amino acids or dimerized vegetable oils. Polyamides are good oxygen and water barriers, but they have low melting points. Polyamides are approved for use as food contact coating on materials not to exceed room temperatures, as a component of paperboard, as sealing gaskets for food containers, and as film coatings. Certain polyamides are approved for higher temperature applications. Nylon-66 has a very high melting point but is difficult to heat-seal. Heat distortion occurs at 400^{0}F; maximum continuous service temperature is 175^{0}F.

PP

Polypropylene. Polypropylene was introduced in the 1950s. It is very transparent but cracks and breaks at low temperatures (15^{0}F). It was used successfully in the mid-1960s as a copolymer with PE but was eventually replaced by plain PE for bags. It is more rigid, stronger, and lighter than PE. It is resistant to water vapor, grease, acids, bases, and solvents, and some polypropylenes are resistant to high temperature. Heat distortion occurs at 113^{0}F; maximum continuous service temperature is 100^{0}F. PP is cleared for irradiation sterilization up to 1 megarad total. Polypropylene is used for yogurt containers, margarine tubs, and bottles for some pourable foods such as syrup.

PS

Polystyrene, a rigid or flexible packaging material. PS is brittle. It heat distorts at 170^{0}F. It is resistant to water, oxygen (but not carbon dioxide), weak acids, bases, and fats and oils, but it is damaged by solvents and alcohol. PS films are approved for irradiation sterilization up to a total of 1 megarad. PS can be formed into a foam that is less brittle than solid PS film. PS can be foamed using n-pentane, isopentane, or toluene as the “blowing agent”; the use of chlorfluorocarbons (CFCs) has been discontinued in the manufacture of items used by the food service industry. PS foam is approved for food use with aqueous acid or nonacid foods and beverages containing no fat or oils. PS foams are used for hot beverage cups, egg cartons, meat trays, and preparation cups for instant foods such as noodles and soups.

PVC

Polyvinyl chloride. It is manufactured by polymerizing vinyl chloride monomer. Plasticizers must be added to give it flexibility. The structure of this polymer is relatively tight, but some air will pass through it. PVC has a heat-distortion temperature of 165^{0}F and a maximum continuous service temperature of 150^{0}F. Because its shrink and melt points are so low, PVC can be used to shrink wrap foods which tolerate very little heat. It is resistant to water, acid, bases, some solvents, fats, and oils. PVC is approved for use as the film to wrap fresh red meats because it allows enough air to pass through the package to make the meat pigments “bloom” bright red. PVC is Prior Sanctioned for use in general food contact applications. The heat-sealing range is from 200 to 350^{0}F. PVC is approved for irradiation sterilization up to 1 megarad.

PVDC

Polyvinylidene chloride, a co-polymer of vinylidene chloride and vinyl chloride or methyl acrylate. PVDC was invented in 1941 to protect equipment from outdoor elements. After World War II, it was approved for food packaging, and it was Prior Sanctioned in 1956 (Society of the Plastics Industry). PVDC is cleared for use as a base polymer in surfaces of materials that contact food, including food package gaskets, coverings that come in direct contact with dry foods, and paperboard coating in contact with fatty and aqueous foods. The copolymerization results in a film with molecules bound so tightly together that very little gas or water can get through. The heat distortion temperature of the polymer is 113^{0}F, and the maximum continuous service temperature is 160^{0}F. PVDC films soften at 250^{0}F, so they can be used with food that is boiling, but not necessarily with high-sugar or high-fat foods that may get much hotter than 212^{0}F. PVDC and PVC can be copolymerized to produce a family of flexible “Sarans.” Sarans are clear and have excellent barrier properties. Their heat-sealing range is from 280 to 400^{0}F. PVDC is resistant to oxygen, water, acids, bases, and solvents.

Susceptor

A thin metalized film joined to a container (often paperboard) with an adhesive. Its purpose is to “heat up” in the microwave oven to cause browning or crisping of microwaveable foods such as pizza or to help generate enough heat to cause popcorn to pop. Susceptors attain temperatures of 450 to 500^{0}F and have the potential for volatilizing the adhesives and plasticizers in the packaging material, causing them to migrate into the food product. First-generation susceptors used aluminum-coated polyester film or paperboard. Second-generation susceptors are currently being developed; they will use nickel, cobalt, iron, and stainless steel to improve the susceptor’s heating capacities.

VCM

Vinyl chloride monomer. PVC can have residues of vinyl chloride monomer (VCM) in the finished plastic film. These levels have been reduced to insignificant amounts since the late 1970s. The Codex Committee on Food Additives and Contaminants has proposed guideline levels of 1ppm for VCM in PVC packages and 0.01 ppm for the monomer in food.

For more information contact the Society of the Plastics Industry, 1275 K Street N.W., Suite 400, Washington, D.C. 20005; (202)371-5200.

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