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TechLiner

Welcome to the TechLiner... a publication from Battenfeld Gloucester Engineering that shares trends and applications in the plastics industry. This newsletter is published 3 times per year. We'd love to hear your comments and input! Please contact Loretta Cobb, Technical Writer at (978)282-9396 or cobb.l@bge.battenfeld.com.

Cast Polypropylene(CPP) Film: An Interesting Product and Growing Market

by German Laverde, Director of Marketing with contributions by Steve Lee, Microprocessor Technician

What is CPP?

CPP allows for exceptional presentation without the risks of altering the taste or leaving residual flavors on the products inside the package.

The term CPP is used in the plastics industry to describe polypropylene-based films produced by a cast extrusion process (Cast Polypropylene). Although there are some CPP films used for hygiene applications and synthetic paper (usually involving fillers and other additives), the term CPP is usually used to refer to high clarity films targeting lamination, metallization and packaging applications. The rapid quench achieved with chill rolls results in excellent film clarity and gloss.

These types of films differ from BOPP (Biaxially-Oriented Polypropylene) because they are not oriented. Orientation is a process that increases the tensile strength of film in a specific direction by stretching or rolling. Strictly speaking, CPP films experience a small amount of orientation, but only in the Machine Direction (MD), due to the nature of the process.

Some of the main characteristics of Cast Polypropylene films are:

- Lower cost, higher yield (sq ft/lb or sq m/kg) than other films such as LLDPE, LDPE, HDPE, PET or PVC
- Higher stiffness than PE films
- Good barrier to moisture and odors
- Versatile for use as a base film for laminates
- Able to be metallized
- Excellent presentation for packaging and wrapping of food and merchandise that requires visibility of the product through its packaging

Abstract

Cast Polypropylene films have been available for some time, but new resin grades and equipment developments have hastened their introduction to new and different applications from the traditional markets. Current raw material prices and new packaging concepts have also had a big influence in promoting CPP films as a good alternative for the flexible packaging industry. Trends towards the use of metallocene-based PP and wider production equipment are the most interesting changes in this market. This article will review the characteristics of these films, market situation, current and potential applications as well as important equipment considerations.

Current Applications

Current Applications:

- Bags for garments, hosiery and flowers
- Pouches
- Wrapping
- Films for files and photo albums
- Food packaging
- Metallized films for barrier packaging and decoration

Potential Applications

Potential Applications:

- Blister packaging (replacing PVC)
- Food wrap
- Candy wrap (twist films)
- Medical packaging (IV bags, medical device pouches, etc.)
- PVC Replacement in photo albums, folders, files, etc.
- Synthetic paper
- Pressure sensitive tapes
- Report covers
- Business card holders

Country	Container	LLDPE hexene	Homopolymer PP
United States	Railcar	29 - 32¢/lb	28 - 31¢/lb
		64 - 70¢/kg	62 - 68¢/kg
Mexico	Bagged	27¢/lb	25¢/lb
		59¢/kg	55¢/kg
W. Europe	Bulk	22.7¢/lb	22.1¢/lb
		50¢/kg	48.6¢/kg
China		No difference in price	

Chart 1: General Reference for Resin Prices in January 2002 (CMAI)

CPP Films are an Attractive Choice as a Material

Resin price

The current market situation offers a price advantage for PP versus materials such as PET, LLDPE, and LDPE. Price differences of 5 or 10%, in addition to a 2% difference in density with LLDPE, could be interesting especially when buying large quantities of resin. Depending on the local market conditions and volumes, the price per pound or per kilo can vary slightly. However according to the Chemical Market Associates, Inc. (CMAI), the chart above depicts a general reference for prices in January 2002. (see chart 1)

High gloss and excellent transparency

Due to the rapid quench inherent to the cast film process, PP film is a very good option to consider for packaging films requiring high clarity. Especially in the current flexible packaging markets, clear windows, which allow the product inside the package to be seen, are very desirable. Different resin grades can be selected to obtain specific properties such as clarity, sealability and better performance during metallizing.

Easy to print by different processes

This characteristic allows the final appearance of the film to be enhanced once it is corona treated.

Good heat resistance

Because PP's softening point is around 266°F (130°C), these films can be used in applications for hot filling, retort and sterilization.

High resistance to acids, alkalis, grease and oil

Where this property is important, CPP is a valid option for the packaging of bakery products or for laminations.

Safe for contact with food

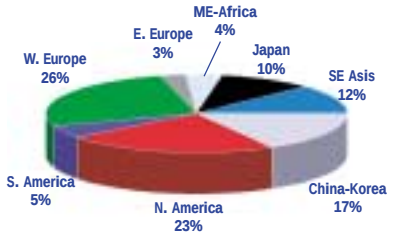
This ensures exceptional presentation without the risks of altering the taste or leaving residual flavors on the products inside the package.

Market Size

CMAI has estimated the total world major thermoplastics demand to be 271.4 billion pounds (123.1 million metric tons) in 2001 with PP representing 22% of the total polymer consumption. Western Europe, North America and Asia are the main polypropylene consumers with a total of 88% of the worldwide demand. Asia alone, which includes Japan, SE Asia, China and Korea, consumes 39% of the world PP demand.

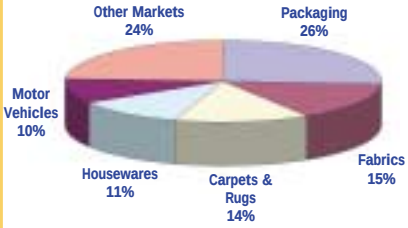
According to the Freedonia Group, the forecast for total PP film demand in the USA in 2002 predicts an average annual growth rate of around 4.5% reaching 1343 million pounds (609,000 metric tons), most of which are BOPP. Food packaging was forecast to represent 85% of this demand. CPP films are not as popular in the USA as in other regions of the world, but lately are starting to be used more for laminations. In Western

World PP Demand by Region
27.1 million metric tons, (59.7 billion lbs.) 1996



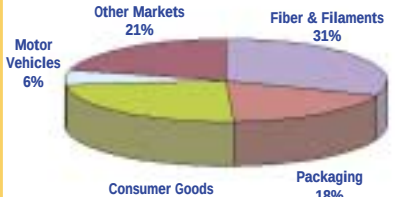
Source: Freedonia Group

U.S. PP Demand by Market
2004



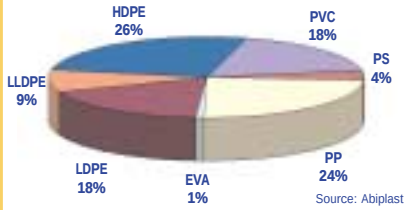
Source: Freedonia Group

Asia/Pacific PP Demand by Market
12505 thousand metric tons 2002



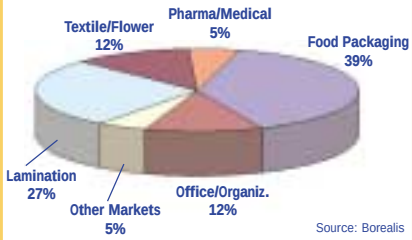
Source: Freedonia Group

Brazilian Plastics Industry
1,796 million metric tons Jan-Jun 2000



Source: Abiplast

Western Europe CPP by Application
423,000 metric tons 2003



Source: Borealis

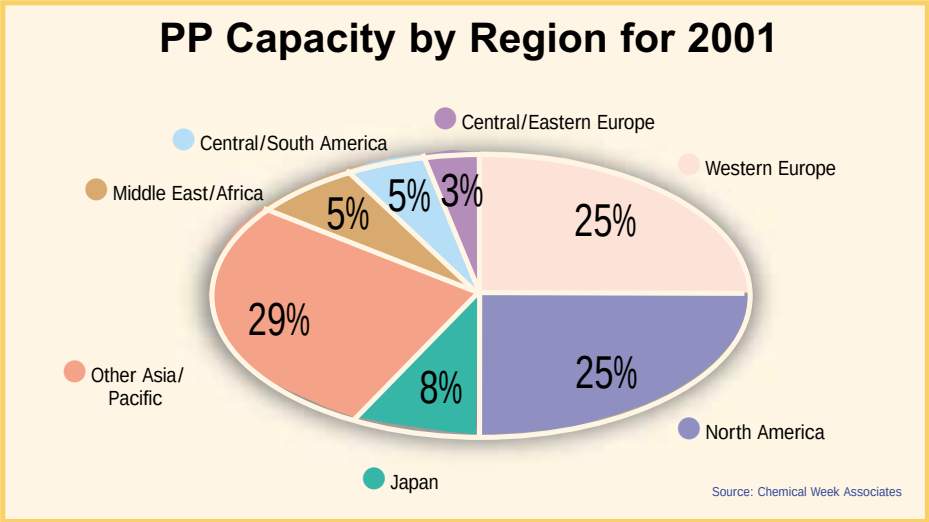
Europe, the PP market was estimated to be 17.9 billion pounds (8.1 million metric tons), according to figures from Borealis. The market size for CPP films in 2003 is estimated to be 933 million pounds (423,000 metric tons) with lamination and food packaging as the main applications.

Cast Polypropylene, especially the metallized grade, is a very interesting material for food packaging in the Asian region. High demand is generated by the material's appearance frequently enhanced by high impact graphics. Japan alone, as an example, consumed 265 million pounds (120,000 metric tons) of CPP films in 1997.

In Latin America, CPP films are becoming more popular and widely used. In general, PP for packaging was forecasted by Freedonia Group to reach around 882 million pounds (400,000 metric tons) by 2002.

Trends in CPP Films

- Increased market share at the expense of PVC, PS and PE
- Increased participation of coextruded structures for demanding applications
- Improvement in sealing properties
- Reduction of processing issues such as plateout
- Increased productivity in film production, secondary operations and final applications
- Better metal adhesion
- Increased participation in non-traditional markets for PP such as lids for desserts, salads, and frozen food; pouches for sauces, snacks, and candies; peelable structures, and twist film
- Replacement of BOPP as a more economic option for less demanding applications such as bread, biscuit, pasta and snack food packaging



Production Equipment

The production equipment for CPP films can be as simple as a monolayer cast extrusion line or more complete and flexible as a 3-layer line. The range of products expected to be produced and the final film applications will dictate the definition and specification of the equipment.

A monolayer line is a low investment option for film production for applications such as flower bouquet wrapping, and some laminations and tape films. A coextrusion line offers excellent flexibility having the ability to combine homopolymer and copolymer PP grades in the structure.

A coextrusion line offers two main possibilities:

- Two extruders able to produce ABA structures (ie. European dedicated lines for stationery products) but imposing some limitations
- Three extruders opening a broader range of options including the capability to produce:
  - monolayer structures (AAA)
  - coextrusions with similar materials on the skin layers (ABA)
  - coextrusions with different materials on the skin layers (ABC)

Most of the modern and competitive lines producing CPP films involve coextrusion, with three layers being a standard for the industry. Usually a larger extruder, 4" or 6" (100 or 150 mm) is specified for the core layer to produce the bulk of the structure. Smaller extruders, 2.5" or 3.5" (60 or 90 mm) feed the skin layers, which open more opportunities to obtain better sealing properties or performance during the metallization process.

Why Coextrusion?

- Ability to combine different PP grades
- Better sealing properties
- Savings by using expensive additives only in skin layers
- Opportunity to use regrind material in the core layer, depending on the final application
- Better lamination performance using specific PP grades in skin layers
- Lower pinhole count

CPP film production is a more demanding and delicate process than CPE (cast polyethylene). The high demand in terms of clarity and thickness uniformity should be considered when determining the

equipment configuration. An automatic die is almost essential to ensure good thickness uniformity. However, what is achieved with the die could be lost if the chill rolls and casting unit do not guarantee an even cooling effect. Chill roll temperature settings, among other parameters determine the amount of plateout and its effect on the film clarity. Slight thickness variations can produce marks and bumps on the roll, making it unusable.

Small details such as the design of the pinning devices and more obviously the soft box specifications and design, will have a big influence on the quality of the film. A successful design will provide a very uniform contact between the melt extrudate and the chill roll resulting in high clarity even at high speeds.

Film temperature control after the corona treater is also important to improve web handling and to reduce the risk of wrinkles and defects in the winder. The winder design is extremely important to guarantee proper winding of a material, which will shrink after aging, increasing the risk of blocking or "bruise" propagation through consecutive layers of film. CPP rolls are usually wound using an air gap mode. The amount the air is determined by the design and adjustability of the devices that control the thickness of the air layer that is wound between successive layers of film. Also, the use of a layon roll may be necessary to control the roll hardness.

Automatic dies and full computer-control of the line including the raw material supply and blending, reduces the process variability and the effect of external variables on the film quality. Also, the melting process of the material is better controlled using optimum screw designs and computer controlled temperatures, diminishing the risk of gels on the film.

Trends in Processing Equipment

Due to the delicacy of the process, CPP production is not a high-rate extrusion process. Though improvements are continuously being made, CPP production rates are still low when compared to the production rates of other products such as stretch film. Since the quality of the film in terms of optical properties and gel count is the most important thing, lower rates are preferred because this ensures higher quality.

High rates reduce the cooling time and can promote more air between the film and the chill roll. Improved designs are being developed to overcome these problems and to ensure excellent roll conformation and winding conditions.

As another alternative, producers are moving towards wider lines to increase the volume and reduce the percentage of edge scrap versus the total film width. Currently, it is not uncommon for lines to produce CPP film in master rolls between 160" – 180" wide (4.0 - 4.5 meters).

Main CPP extrusion line components:

- Blending system
- Extruders (typically 3)
- Feedblock and automatic die
- Combination soft-vacuum box
- Casting unit
- Nuclear thickness gauge
- Treater station
- Winder
- Reclaim system
- Integrated control system

Producers are moving toward wider lines to increase their efficiency.

Materials and Film Properties

The status of materials is definitely affecting the CPP market and fueling its growth. Some of the most noted situations are:

1. Development of new PP grades
2. New catalyst technologies allowing different material structures (Borealis and Basell)
   - High crystalline PP
   - Random heterophasic copolymers
   - Supersoft PP
   - High melt strength PP
3. Metallocenes-based PP, such as materials developed by Exxon and Dow
   - Good processability
   - Clarity

- Stiffness
- Sealability
- Low extractables
- Low volatile content

According to Exxon, easier drawdown at higher rates processing can be achieved using metallocene based PP in comparison to traditional grades.

Different combinations are used to produce CPP films, but a typical structure is:

Layer A: CoPP
(Random Copolymer PP)

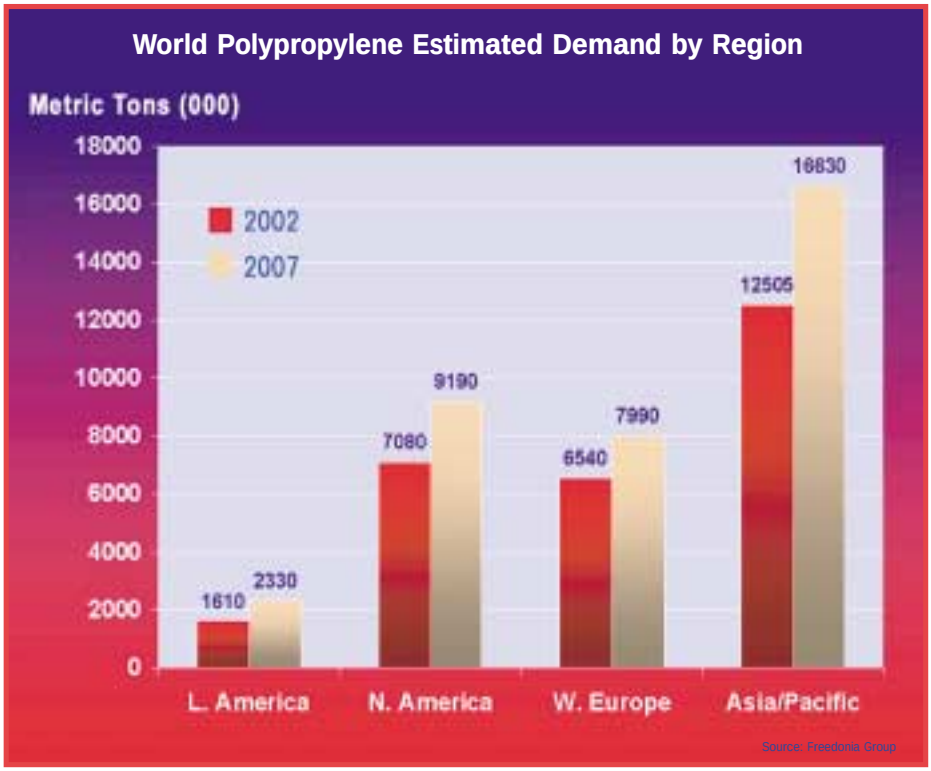
Layer B: Homopolymer PP

Layer C: CoPP
(low seal initiation temperature with slip and antiblock additives)

The materials selected for each layer can be different and still be CoPP or HomoPP depending on the effects desired and the final application. For example, the general formulation can still be the same, but different grades are used if the film is going to be used for metallization, lamination or retort applications.

Metallization film requires excellent optical properties with haze values not higher than 2% for a 20 micron (.8 mil) 3-layer coextruded film. A lamination type film can have values up to 2.5% in haze, and a retort type film can have values up to 5%, but the sealing strength required can be almost twice the other types.

In the case of twist film for candy wrap probably the most important property is the dead fold and twist retention or memory. Other applications such as IV solution bags will need a 3-layer structure; using a high crystalline grade for heat resistance and moisture vapor transmission rate properties in one skin layer, a flexible PP grade in the core, and a CoPP with very good sealing properties in the other skin layer.



Conclusions

CPP films are a good alternative for traditional and developing applications. The new PP grades and technologies are opening a broader range of applications even at the expense of other traditional materials. High demands in terms of quality make the cast PP process more dependent on a good selection of raw materials, process equipment and processing conditions. The extent of knowledge and the control of these parameters will make the difference among the film producers.

German Laverde
Director of Marketing

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Microprocessor Technician

History of Plastics

In today's world, life without plastics is incomprehensible. We all know the many ways that plastics contribute to our health, safety and peace of mind. But how did the material plastic come about? Who were the key individuals in its development and use? In each TechLiner issue we will feature one element of plastic's amazing history.

Discovery of Rayon

Rayon was first developed in 1891 in Paris by Louis Marie Hilaire Bernigaut, the Count of Chardonnet. He was searching for a way to produce man-made silk. After studying silkworms, Chardonnet noticed that the worms secreted from a narrow orifice a liquid that hardened upon exposure to air and turned into silk. He deduced that if he could find a liquid that would have similar characteristics to silk before being secreted, he could then pass it through a man-made apparatus to form fibers that could be spun and feel like silk. The only problem with his new invention was that it was highly flammable. This problem was later solved by other scientists. Originally called "artificial silk", the name was changed to rayon in 1924.

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