Plastic Packaging Resins

Resin Codes	Descriptions	Properties	Product Applications	Products Made with Recycled Content*
1 PET	**Polyethylene Terephthalate (PET, PETE).** PET is clear, tough, and has good gas and moisture barrier properties. This resin is commonly used in beverage bottles and many injection-molded consumer product containers. Cleaned, recycled PET flakes and pellets are in great demand for spinning fiber for carpet yarns, producing fiberfill and geo-textiles. Nickname: Polyester.	• Clear and optically smooth surfaces for oriented films and bottles • Excellent barrier to oxygen, water, and carbon dioxide • High impact capability and shatter resistance • Excellent resistance to most solvents • Capability for hot-filling	Plastic bottles for soft drinks, water, juice, sports drinks, beer, mouthwash, catsup and salad dressing. Food jars for peanut butter, jelly, jam and pickles. Ovenable film and microwavable food trays. In addition to packaging, PET's major uses are textiles, monofilament, carpet, strapping, films, and engineering moldings.	Fiber for carpet, fleece jackets, comforter fill, and tote bags. Containers for food, beverages (bottles), and non-food items. Film and sheet. Strapping.
2 HDPE	**High Density Polyethylene (HDPE).** HDPE is used to make many types of bottles. Unpigmented bottles are translucent, have good barrier properties and stiffness, and are well suited to packaging products with a short shelf life such as milk. Because HDPE has good chemical resistance, it is used for packaging many household and industrial chemicals such as detergents and bleach. Pigmented HDPE bottles have better stress crack resistance than unpigmented HDPE.	• Excellent resistance to most solvents • Higher tensile strength compared to other forms of polyethylene • Relatively stiff material with useful temperature capabilities	Bottles for milk, water, juice, cosmetics, shampoo, dish and laundry detergents, and household cleaners. Bags for groceries and retail purchases. Cereal box liners. Reusable shipping containers. In addition to packaging, HDPE's major uses are in injection molding applications, extruded pipe and conduit, plastic wood composites, and wire and cable covering.	Bottles for non-food items, such as shampoo, conditioner, liquid laundry detergent, household cleaners, motor oil and antifreeze. Plastic lumber for outdoor decking, fencing and picnic tables. Pipe, floor tiles, buckets, crates, flower pots, garden edging, film and sheet, and recycling bins.

Resin Codes	Descriptions	Properties	Product Applications	Products Made with Recycled Content*
3 PVC	**Polyvinyl Chloride (PVC, Vinyl).** In addition to its stable physical properties, PVC has good chemical resistance, weatherability, flow characteristics and stable electrical properties. The diverse slate of vinyl products can be broadly divided into rigid and flexible materials.	• High impact strength, brilliant clarity, excellent processing performance • Resistance to grease, oil and chemicals	Rigid packaging applications include blister packs and clamshells. Flexible packaging uses include bags for bedding and medical, shrink wrap, deli and meet wrap and tamper resistance. In addition to packaging, PVC's major uses are rigid applications such as pipe, siding, window frames, fencing, decking and railing. Flexible applications include medical products such as blood bags and medical tubing, wire and cable insulation, carpet backing, and flooring.	Pipe, decking, fencing, paneling, gutters, carpet backing, floor tiles and mats, resilient flooring, mud flaps, cassette trays, electrical boxes, cables, traffic cones, garden hose, and mobile home skirting. Packaging, film and sheet, and loose-leaf binders.
4 LDPE	**Low Density Polyethylene (LDPE).** LDPE is used predominately in film applications due to its toughness, flexibility and relative transparency, making it popular for use in applications where heat sealing is necessary. LDPE also is used to manufacture some flexible lids and bottles as well as in wire and cable applications. Includes Linear Low Density Polyethylene (LLDPE).	• Excellent resistance to acids, bases and vegetable oils • Toughness, flexibility and relative transparency (good combination of properties for packaging applications requiring heat-sealing)	Bags for dry cleaning, newspapers, bread, frozen foods, fresh produce, and household garbage. Shrink wrap and stretch film. Coatings for paper milk cartons and hot and cold beverage cups. Container lids. Toys. Squeezable bottles (e.g., honey and mustard). In addition to packaging, LDPE's major uses are in injection molding applications, adhesives and sealants, and wire and cable coverings.	Shipping envelopes, garbage can liners, floor tile, paneling, furniture, film and sheet, compost bins, trash cans, landscape timber, and outdoor lumber.
5 PP	**Polypropylene (PP).** PP has good chemical resistance, is strong, and has a high melting point making it good for hot-fill liquids. This resin is found in flexible and rigid packaging, fibers, and large molded parts for automotive and consumer products.	• Excellent optical clarity in biaxially oriented films and stretch blow molded containers • Low moisture vapor transmission • Inertness toward	Containers for yogurt, margarine, takeout meals, and deli foods. Medicine bottles. Bottle caps and closures. Bottles for catsup and syrup. In addition to packaging, PP's major uses are in fibers, appliances and	Automobile applications, such as battery cases, signal lights, battery cables, brooms and brushes, ice scrapers, oil funnels, and bicycle racks. Garden rakes, storage bins, shipping pallets, sheeting, trays.

Resin Codes	Descriptions	Properties	Product Applications	Products Made with Recycled Content*
		acids, alkalis and most solvents	consumer products, including durable applications such as automotive and carpeting.	
6 PS	**Polystyrene (PS).** PS is a versatile plastic that can be rigid or foamed. General purpose polystyrene is clear, hard and brittle. It has a relatively low melting point. Typical applications include protective packaging, foodservice packaging, bottles, and food containers. PS is often combined with rubber to make high impact polystyrene (HIPS) which is used for packaging and durable applications requiring toughness, but not clarity.	• Excellent moisture barrier for short shelf life products • Excellent optical clarity in general purpose form • Significant stiffness in both foamed and rigid forms. • Low density and high stiffness in foamed applications • Low thermal conductivity and excellent insulation properties in foamed form	Food service items, such as cups, plates, bowls, cutlery, hinged takeout containers (clamshells), meat and poultry trays, and rigid food containers (e.g., yogurt). These items may be made with foamed or non-foamed PS. Protective foam packaging for furniture, electronics and other delicate items. Packing peanuts, known as "loose fill." Compact disc cases and aspirin bottles. In addition to packaging, PS's major uses are in agricultural trays, electronic housings, cable spools, building insulation, video cassette cartridges, coat hangers, and medical products and toys.	Thermal insulation, thermometers, light switch plates, vents, desk trays, rulers, and license plate frames. Cameras or video cassette casings. Foamed foodservice applications, such as egg shell cartons. Plastic mouldings (i.e., wood replacement products). Expandable polystyrene (EPS) foam protective packaging.
7 OTHER	**Other.** Use of this code indicates that a package is made with a resin other than the six listed above, or is made of more than one resin and used in a multi-layer combination.	Dependent on resin or combination of resins	Three- and five-gallon reusable water bottles, some citrus juice and catsup bottles. Oven-baking bags, barrier layers, and custom packaging.	Bottles and plastic lumber applications.

***Recycling may not be available in all areas. Check to see if plastics recycling is available in your community.**

Plastics Recycling Poster Assignment

Objective: To become aware of and gain an understanding of the impacts of plastics as a post consumer product, including the problems created by consumer plastics and alternative solutions to these problems. To know what you as a consumer can do to minimize the effects of consumer plastics on society.

Assignment: To produce a poster that creatively and clearly shows the recycling alternatives for plastics. Your poster must include the following information.

1. Correctly identified and spelled names of the seven plastics covered in the recycling guidelines. This might include more than one name, a trade name and a scientific name. (i.e.: Styrofoam and polystyrene.) (2 points for each one, 14 total.)
2. Two samples of each of the seven recyclable plastics. These samples must include the recycle number molded into the product. There is only one of these on each product. (1.5 points for each one, 21 total.)
3. A correct, original diagram of the **"mer"** of the plastic that you are identifying. (2 points for each one, 14 total.)
4. Identify where your sample came from and list common uses. (There are thousands of uses!!!) (2 points for each one, 14 total.)
5. The recycle symbol with the correct number inside. (1 point for each one, 7 total.)

Format: Your assignment is to be done on a rigid poster board type of material. It must be visually pleasing and factually accurate. Whatever arrangement you decide upon must have some reason and logic behind it. Either drawing by hand or using a computer is acceptable. However, the poster must be neat and clean. Items must stay attached so select an adhesive that will do the job on a permanent basis. (15 points total.)

Total points possible for assignment: 85

Due Date = __________________________

For each date your poster is turned in late, 15% will be deducted from the final point total.

Some class time will be given to work on your poster. However, you will need to bring materials from home to be able to complete the project. These materials will need to be at school so that your class time is used efficiently.

Plastics and Polarization

Name: ____________________________

Date: ______________ Period: ________

As you experiment with your set of polarizing lenses, read the "Background Information" and answer the following questions:

1. How is ordinary light different than polarized light?

2. How does a polarizer affect ordinary light waves?

3. How would you know if two polarizing filters were parallel to each other?

4. How would you know if two polarizing filters were perpendicular to each other?

5. Give two examples of the use of polarizing films.

6. What effect does the cellophane tape have on the light that passes through it?

7. If you locate the color red in the polariscope and then turn one of the films 90 degrees, what color do you get?

Collect two other types of clear plastic. One should be from a plastic box (available from the instructor) and another from a 2 liter pop bottle. Place them between the polarizing films and record your observations before and after rotating the films 90 degrees. Also, include a record of the results from just the cellophane tape.

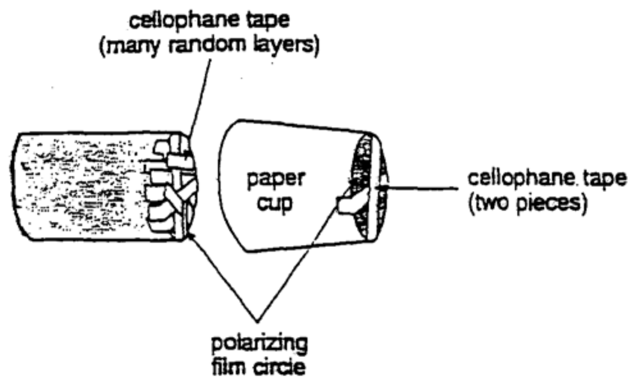
Type of plastic	Initial color	Color after 90 degree rotation

Plastics and Polarization

How do Polaroid sunglasses work? Sunglasses are polarizers that have the ability to block out some of the sunlight. In this activity you will be able to duplicate this process using polarizing film. You will observe how an optically active material like cellophane, when placed between such polarizing films, will rotate certain light waves. As more layers of cellophane are added in the activity, the degree of rotation of the wavelengths of light is increased and more colors become visible.

Materials (per group)

- 2 square pieces of polarizing material (about 1" x 1")
- 2 small paper cups with bottoms removed
- cellophane tape
- scissors
- pieces of other types of clear plastic

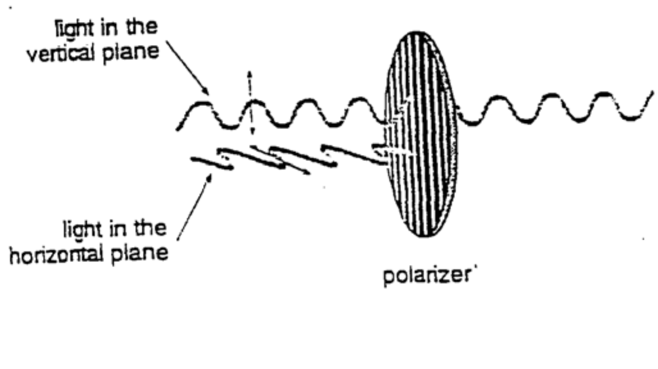


Procedures:

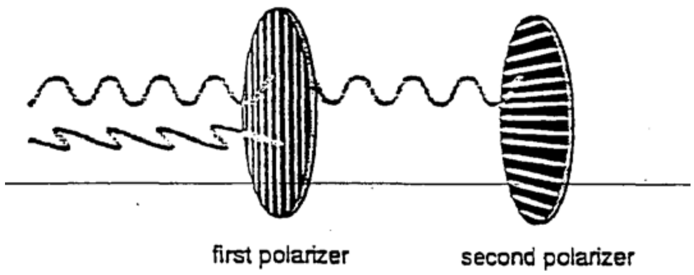
1. Cut out the bottom of each of the small cups.
2. Tape a piece of polarizing material to the bottom of each cup with clear tape.
3. Take at least two more pieces of tape and cover the bottom of the cup in a variety of directions – more layers of tape placed over the polarizing film will produce more "colorful" results.
4. Repeat the above procedure with the other cup.
5. Place one cup inside the other and look through the opening holding the cups to the light. Rotate the paper cups and observe the colored lights that are visible.
6. As you experiment with your set of polarizing lenses, read the "Background Information" packet and answer the questions on the worksheet.

Background Information

Ordinary light from the sun or a lamp is composed of waves that vibrate in all directions perpendicular to the light beam. Polarized light vibrates in a single direction perpendicular to its path. Ordinary light can be polarized by passing it through a polarizing filter. This filter allows only the waves that vibrate in one perpendicular direction to pass through. The structure of the light-polarizing filter prevents the passage of light waves that vibrate in other perpendicular directions.



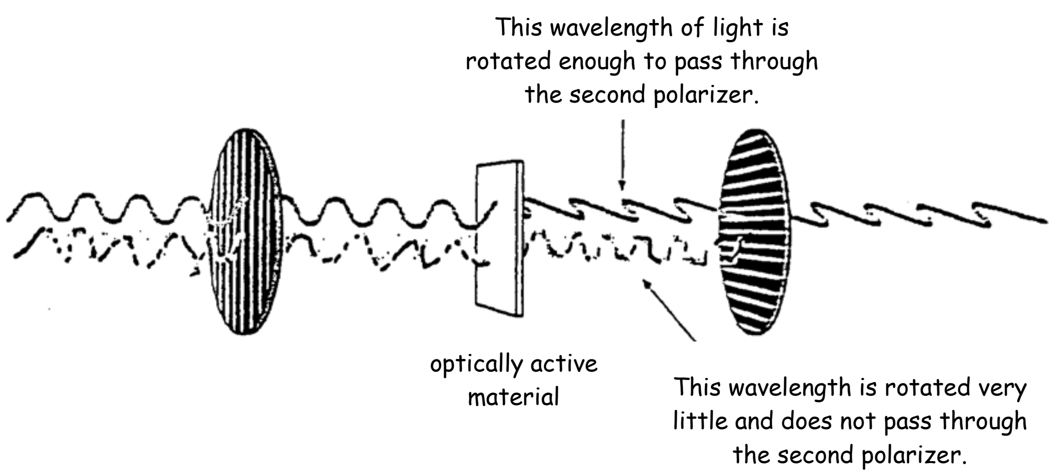
Polarized light can pass completely through a second polarizing filter, which is parallel to that of the first polarizing filter. If the second polarizer is rotated, it will gradually dim the light that comes through it. The second polarizer will cut off the light entirely when its axis is 90° to the axis of the first polarizing filter.



The effect of the second polarizer's orientation on plane polarized light.

Many applications of polarized light are based on this phenomenon. Polarized sunglasses, with their transmission axis set vertically, block the horizontally polarized light. Photographers use polarizing filters to cut down on glare and reflections from shiny surfaces.

When a piece of cellophane tape is placed between two crossed polarizing films, light now passes through because the cellophane has the ability to rotate the plane of light. This is referred to as optical activity. Many polymer films are optically active because they have been stretched during manufacturing and their molecules are aligned in the direction of the stretch. As light passes through the stretched polymers, they rotate the light waves. Not all optically active substances rotate all wavelengths of light to the same degree. This causes certain frequencies not to pass through the second polarizer. The wavelengths passing through the second polarizer will appear a certain color. As the outer polarizing film is rotated in our activity, the orientation of the polarizer changes. Different wavelengths pass through and different colors are visible. As you rotate by 90 degrees, a color changes to its complementary color.



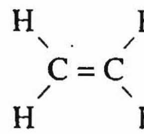
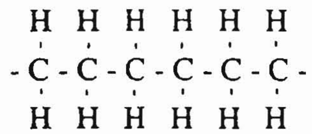
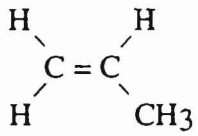
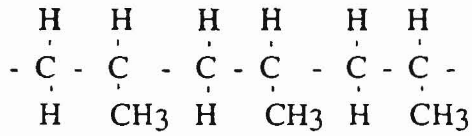
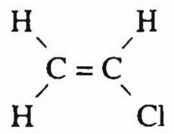
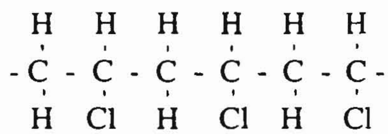
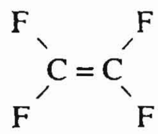
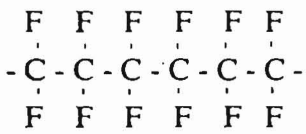
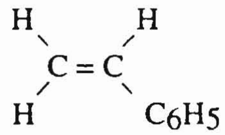
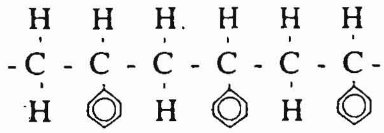
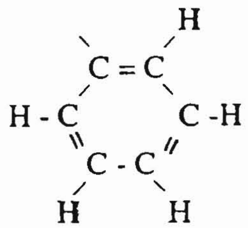
The effect of optically active materials on plane polarized light.

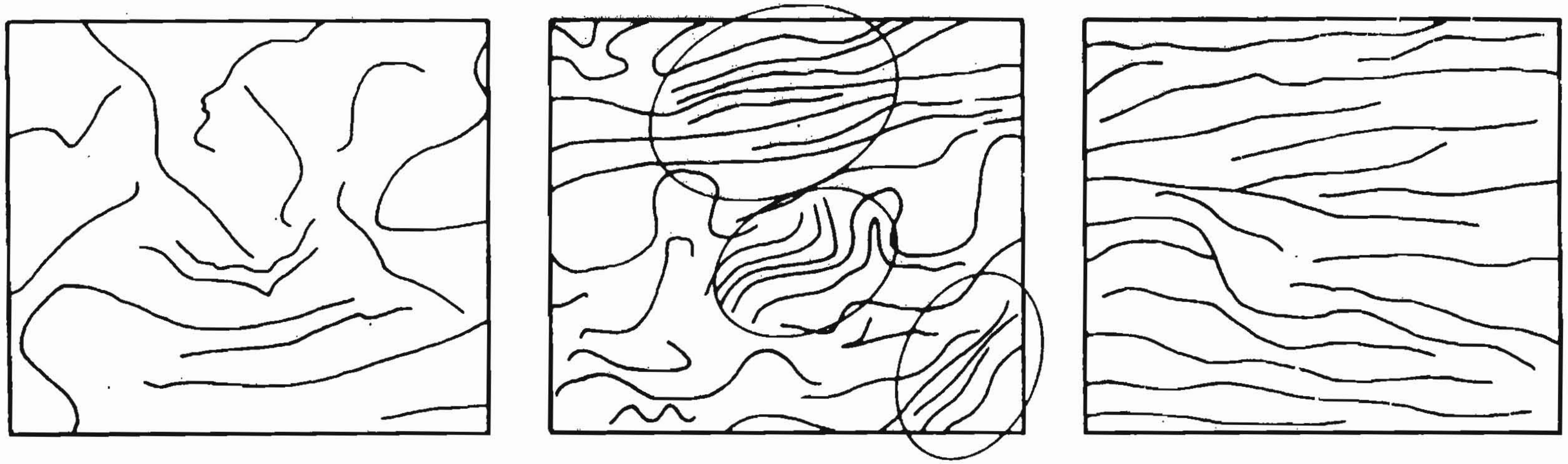
Recycling Codes

Recycling Symbol		Name of Polymer	Sample Uses
1	PETE	polyethylene terephthalate	• soft drink bottles • carpets • fiberfill • rope • scouring pads • fabrics • Mylar tape (cassette and computer)
2	HDPE	high density polyethylene	• milk jugs • detergent bottles • bags • plastic lumber • garden furniture • flowerpots • trash cans • signs
3	V	vinyl	• cooking oil bottles • drainage and sewer pipes • tile • bird feeders • institutional furniture • credit cards
4	LDPE	low density polyethylene	• bags • Elmer's® Glue bottles and other squeeze bottles • wrapping films • container lids
5	PP	polypropylene	• yogurt containers • automobile batteries • bottles • lab equipment • carpets • rope • wrapping films
6	PS	polystyrene	• disposable cups and utensils • toys • lighting and signs • construction • foam containers and insulation
7	other	all other polymers	• catsup, snack, and other food containers • hand cream, toothpaste, and cosmetic containers

Density Table

Type of Plastic / Floats On		Vegetable Oil	Alcohol/Water	Water	Glycerin
PETE	#1	no	no	no	no
HDPE	#2	no	no	yes	yes
V	#3	no	no	no	no
LDPE	#4	no	yes	yes	yes
PP	#5	yes	yes	yes	yes
PS	#6	no	no	no	yes

Name	Mer	Polymer
Polyethylene		
Polypropylene		
Polyvinyl Chloride		
Polytetrafluoroethylene (Teflon)		
Polystyrene*		
*The structural formula for C_6H_5 is:		Abbreviated: 



(a) Mostly amorphous

(b) Semicrystalline (crystallites encircled)

(c) Mostly crystalline

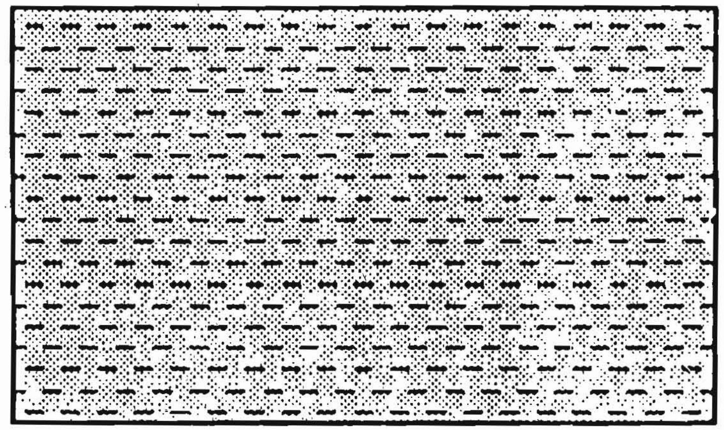


Figure 6-7 Degrees of crystalline structure of polymers.

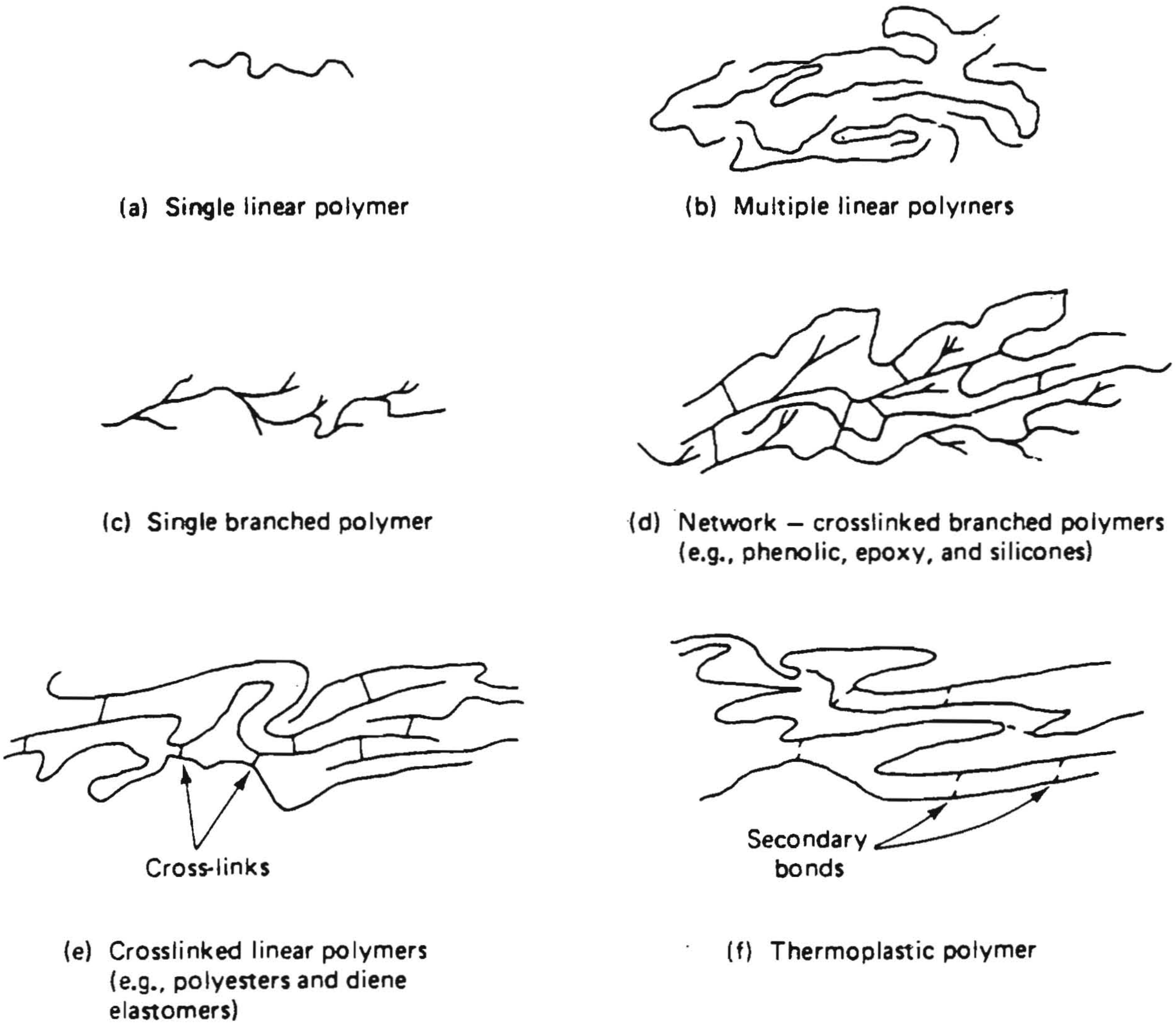


Figure 6-10 Various polymer structures.