



What are Polymers?

What role do they play in our
world?

Presented By Maggie and David Baumann

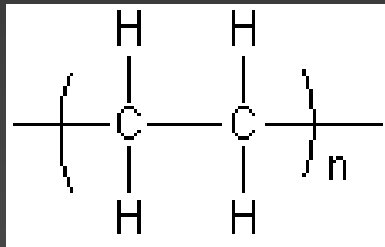
April 24, 2006

Definition of a Polymer

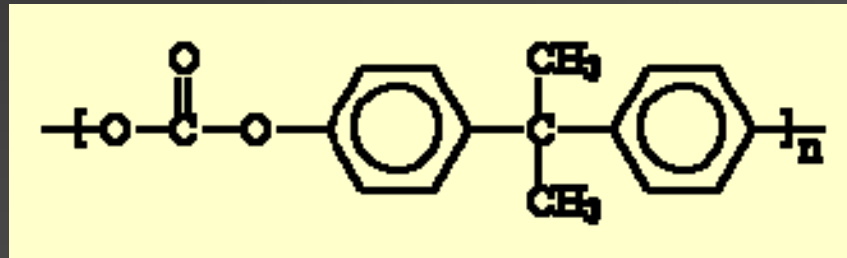
- A polymer is something made of many units or monomers.
 - Think of a polymer as a chain-each link of the chain is the “mer” or basic unit that is usually made up of Carbon, Hydrogen, Oxygen and/or silicon. To make the chain the many links or “mers” are hooked or polymerized together.
-

Examples of polymer structures

- Structure



Polyethylene



Polycarbonate

There are two major families

- Carbon based--C
- Silicone based- Si (one of the most famous silicon based polymers is Silly Putty).
- The other elements that are most commonly found in Polymers are:
 - Hydrogen – H
 - Oxygen- O
 - Nitrogen - N
 - Chlorine- Cl
 - Fluorine- F
 - Sulfur-S
 - Phosphorus- Ph

Classes of Polymers

- There are two main types of polymers
 - Thermoset
 - Thermoplastic
-

Thermosets

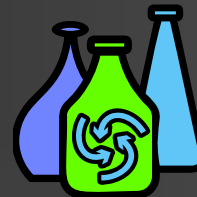
- Polymers that when formed cannot be re-melted and formed again
 - Examples:
 - Polyurethane- used in foam cushions, bedding, and in insulation.
 - Epoxies- commonly used in adhesives and electrical components
 - Phenolics- commonly used in industrial coatings and high temperature appliance parts
 - Polyesters- used in fiberglass for boat hulls and recreational vehicles; shower stalls
-

Thermoplastics



- These are plastic materials that when formed can be re-melted and therefore re-formed. These are the materials that are most commonly recycled.

- Examples



- Polyethylene—Bottles, bags
- PET (thermoplastic polyester)- bottles, fibers
- Polypropylene- film, automobile parts
- PVC- vinyl- used in house siding, fencing and plumbing pipes and fittings



Elastomers

- These can be thermoset or thermoplastics but their distinguishing characteristic is that they are rubbery.
- Examples
 - Polyisoprene- (synthetic latex or natural rubber)
 - Silicone rubber
 - Neoprene and EPDM- used in tires



Broad variety of polymer types

- Volume - e.g. Polyethylene, Polypropylene, Polyvinyl Chloride
- Engineering- e.g. polycarbonate (Lexan), nylon
- High Performance- e.g. Teflon, PEEK

Many chemical variations...and compounds

Traditional materials

- Those that can be mined or forested
 - Iron
 - Glass
 - Wood
 - Wood pulp/paper
 - Latex rubber from rubber trees
-

What are the advantages of polymers vs. these traditional materials?

- Can be produced in a processing plant
 - Are more flexible
 - Lighter weight
 - Use less energy
 - More design options
-

What are the disadvantages...

- Based on petroleum by-products
 - Depleting resource
 - Do not quickly degrade in the environment
 - Running out of landfills
 - For some applications, inferior properties
 - Steel is still used for structural applications
 - Glass is still used -ultra pure, optical clarity
 - Wood is still commonly used as a building material
-

Major Processing Methods

- Injection molding
 - Pelletized materials are melted and pushed into a mold under pressure.
 - The mold causes the material to set up (harden) and form a part
 - Example
 - Cell phone housing



Major Processing Methods

■ Extrusion

- Pelletized materials are melted and pulled through a die to form a variety of simple shapes- film, sheet or profiles

- Examples

- Saran wrap
 - Bags
 - Tube/pipe
-

Major Processing Methods

- Blow-Molding

- Pelletized materials are melted and formed into a pre-form; air is introduced to push the pre-form into a bottle-like shape

- Examples

- Bottles
 - Tanks

Major Processing Methods

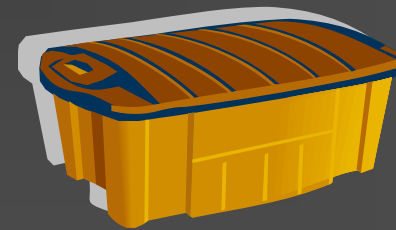
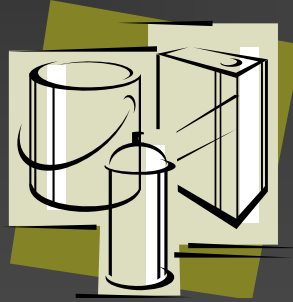
- Casting/Calendering
 - Typically used for thermoset materials
 - The material is introduced in two parts- A and B that when combined in a mold form a component – Casting– (similar to pouring chocolate into a candy mold)
 - Materials are combined in a mill and extruded- Calendering (similar to making bread or pasta)
-

Why so many types and shapes?

- Depends on what “properties” you need
 - Temperature resistance
 - Impact resistance
 - Colorability
 - Transparency
 - Weatherability
 - Chemical resistance
-

Major applications

- Packaging – over 27 % of all plastics used are used in packaging applications
 - Grocery sacks- other shopping bags
 - Soda bottles
 - Milk bottles
 - Stand-up pouches
 - Plastic wrap
 - Meat and produce trays
 - Liquid detergent
 - Shampoo bottles



Major applications

- Automotive

- Bumpers
- Batteries
- Side-trim
- Lighting



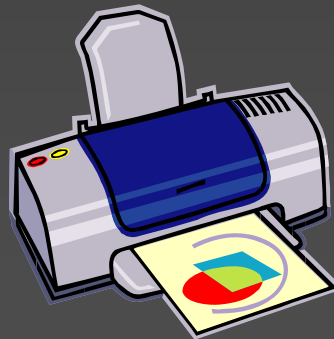
- Interiors- a lot of the interior of the vehicle is polymeric or plastic based today

Major applications



- Consumer electronics/business machines

- Cell phones
- Play Station/X-box
- CDs/DVDs/players
- Desktop and laptop computers
- Printers



Major applications



■ Appliances

- Mostly small appliances but also used in parts on large appliances

- Coffee makers
- Blenders, mixers
- Vacuum cleaners
- Refrigerator liners, shelves and bins
- Washer tubs
- Knobs, buttons, and displays



Major applications

■ Sporting goods/recreation/toys

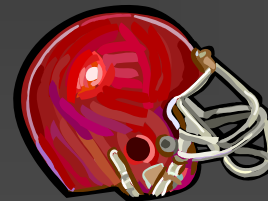
■ Thermosets/composites

- Tennis rackets
- Skis
- Golf clubs and balls



■ Thermoplastics

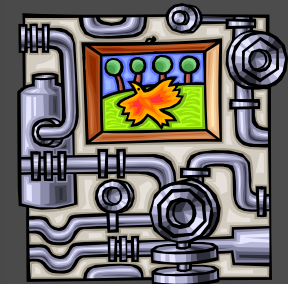
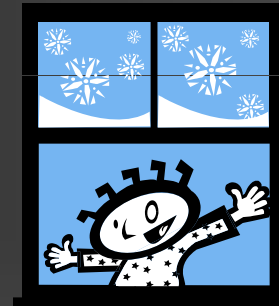
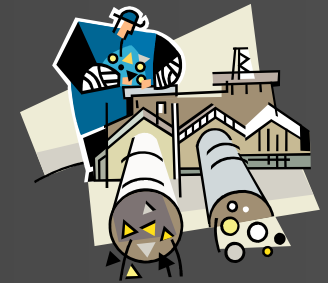
- Helmets, protective pads
- Toys
 - K-Nex, LEGOs
 - Dolls
 - Games
 - Outdoor play



Major applications

■ Industrial/ Building and Construction

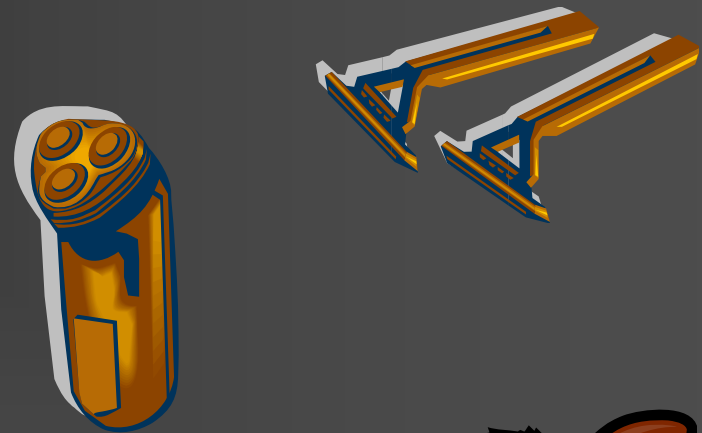
- Wiring
- Pipe
- Siding
- Window and door profiles
- Weather-stripping
- Connectors and fasteners



Major applications

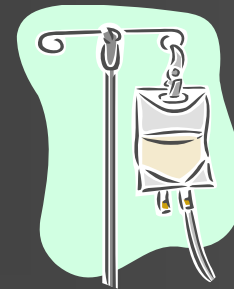
- Consumer/Personal Care

- Toothbrushes
- Cosmetic containers
- Razors
- Hair brushes
- Hair dryers/curling irons



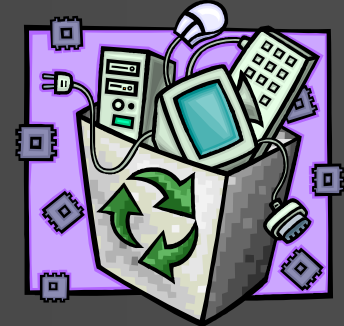
Major applications

- Medical/Healthcare
 - Disposable syringes
 - Blood and Insulin Bags
 - Handles for surgical devices
 - Medical tubing
 - Prosthetics (artificial limbs)
 - Bandages and wound care



Plastics and the Environment

- There are various methods to handle plastic materials
 - Minimize
 - Re-cycle
 - Re-use
 - Incineration- “burning them for energy”
 - Bio-based materials and composting



Plastics and the Environment

■ Minimize

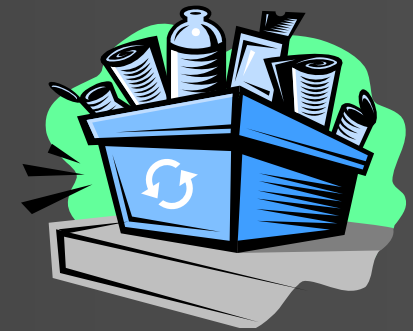
- The plastic materials today are stronger and use less plastic than the same applications a few years ago
 - Designers look for ways to minimize in packaging that will need to be disposed
-

Plastics and the Environment

■ Re-cycle

■ #1 and #2 containers are re-cycled

- Milk bottles
- Soft drinks
- Water
- Sport drinks
- Cleaning products



■ Other mixed plastics are used in decking and fencing materials—“plastic lumber”

Plastics and the Environment

■ Re-Use

- Large polycarbonate water bottles are re-used
 - Metal coatings and electronic components are separated and re-used
 - Medical devices are sterilized for re-use
-

Plastics and the Environment

■ Incineration

- The Japanese use incineration as a way to get the energy out of plastic products that have been disposed
- Some US industrial plants incinerate plastic waste for its energy



Plastics and the Environment

- **Bio-based materials and Composting**
 - Some materials are biodegradable – those are degraded by moisture and sun
 - Some polymeric materials based on corn are composted- that is degraded under a specific set of conditions
 - More polymers are being based on raw materials other than petroleum- those that can be grown as crops.



Summary

- I hope we have helped you understand the world of polymers and plastics a little better.
 - Many of the products that we rely on in our lives today are based on polymers.
 - The future for polymer applications continues to look bright...
-

Reference websites

- The following websites are good sources for information on plastics and chemicals
 - Chemical Heritage Foundation
www.chemicalheritage.org
 - American Plastics Council
www.americanplasticscouncil.org
 - Plasticsresource.org
-