Educational Innovations®

HEA-500

Thermoplastic Polymer

A thermoplastic polymer is a type of plastic that changes properties when heated and cooled. Thermoplastics become soft when heat is applied and have a smooth, hard finish when cooled. Thermoplastics are amazingly versatile and can be heated and re-molded over and over again. This polymer conveniently melts at 58 to 60° C.

Procedure

Materials
Hot water above 78°C
Glass beaker
Glass stirring rod
Tongs
Thermoplastic Polymer

Procedure

1. Pour a number of thermoplastic polymer granules into the hot water in the glass beaker.

2. Stir the granules with the glass rod while observing the color change that takes place. The granules will become pliable and sticky and cling to each other. When all of the polymer has turned translucent, the polymer has melted.

3. Lift the softened polymer from the hot water using tongs or the glass rod.

4. The polymer will remain pliable for 5-7 minutes and can be molded into many different shapes. If students are not happy with their first attempt, they can put the polymer back in the hot water to soften.

Warning: Do not overheat! The melted polymer may be hot! Instruct students not to put the polymer into their mouths. It will bond to metal braces. Students should not make bracelets or rings as the polymer will harden and be difficult to remove.

What is happening?

A chocolate slab can be heated and shaped into an Easter egg. On a hot day the Easter egg, again, is transformed into a new shape. Some polymers can be melted, cooled and re-melted just as with chocolate.

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Polymers that can be heated and reformed over and over again are known as ***thermoplastics***. This group makes up the majority of man-made polymers. These polymers can be shaped into any form. After heating, it can be shaped by extrusion – that is forcing it through a die. A heated polymer can also be poured or pressed into a mold. This is called molding.

On the other hand, when heat is applied to a raw egg, it solidifies as it is transformed into a solid boiled egg. After cooling, it cannot be transformed into another shape by heating. A group of polymers behave similarly. This type of polymer is known as ***thermoset polymers***. These plastics undergo an irreversible molecular change when sufficient heat is applied. Their molecules form cross linkages, and this creates a rigid, permanent structure. Just as a boiled egg can't be un-boiled, thermoset plastics can't be softened again once it is heated and formed. We use thermosets in applications where durability, heat resistance, and strength are determining factors, for example as pan handles, refrigerator insulation, car parts, and in the electrical and space industries.

Thermoplastic Polymers	**Thermoset Polymers**
Can be heated and molded over and over	Once formed it cannot be softened by heat
Have long, unconnected molecule chains with few or no crosslinks	Have many crosslinks between the polymer chains, forming a rigid structure
Can ignite and burn when heated	Usually resists burning, but may char at high temperatures
Examples: Styrofoam packing peanuts, polystyrene plastics, plastic bottles, etc.	**Examples**: Epoxies, polyesters, RIM Urethane

Real Life Applications of Thermoplastic Polymers
Many applications take advantage of the material remaining workable for a period when cooled below the melting point. Applications are:

- Shoe soles, heels and toe stiffeners
- Hot melt glues
- Rigid and lightweight splints and casts replacing Plaster of Paris as orthopedic support
- Orthodontic molding systems, etc

Disposal
Can be re-used many times. If there is a need to dispose of the polymer then do so in compliance with local/federal regulations. This product is not significantly hazardous for the environment and is biodegradable in soil.

