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Educational Innovations Inc.®

Thermoplastic Polymer

HEA-500

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 remolded over and over again. This polymer conveniently melts at 58 to 60 C.

Materials:

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

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.

Disposal:

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

5 Francis J. Clarke Circle, Bethel, CT 06801

Phone (203) 74-TEACH (83224)
www.TeacherSource.com

Explanation

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. 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 they are 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 repeatedly Have long, unconnected molecule chains with few or no crosslinks Can ignite and burn when heated **Examples:** Styrofoam packing peanuts, polystyrene plastics, plastic bottles	Once formed it cannot be softened by heat Have many crosslinks between the polymer chains, forming a rigid structure Usually resists burning, but may char at high temperatures **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. For instance:

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

NGSS Correlations

Our Thermoplastic Polymer and these lesson ideas will support your students' understanding of these Next Generation Science Standards (NGSS):

Elementary

2-PS1-1
Students can use Thermoplastic Polymer to plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

2-PS1-2
Students can analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

2-PS1-3
Students can use Thermoplastic Polymer to make observations to construct an evidence-based account of how an object make of small set of pieces can be disassembled and made into a new object.

2-PS1-4
Students can use Thermoplastic Polymer in an investigation to construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.

5-PS1-3
Students can use Thermoplastic Polymer to make observations and measurements to identify materials based on their properties.

Middle School

MS-PS1-4
Students can use Thermoplastic Polymer in an investigation to develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

MS-ETS1-4
Students can use Thermoplastic Polymer in an investigation to develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

DCI/MS-ETS1.B: Developing Possible Solutions
A solution needs to be tested, and then modified based on the test results in order to improve it.

High School

HS-PS2-6
Students can use Thermoplastic Polymer in an investigation to observe and communicate scientific information about why the molecular-level structure is important in the functioning of a material.

Take Your Lesson Further

As science teachers ourselves, we know how much effort goes into preparing lessons. For us, "*Teachers Serving Teachers*" isn't just a slogan—it's our promise to you!

Please visit our website for more lesson ideas:

TeacherSource.com/lessons

Check our blog for classroom-tested teaching plans on dozens of topics:

http://blog.TeacherSource.com

To extend your lesson, consider these Educational Innovations products:

Chemical Heat Pack (HEA-400)

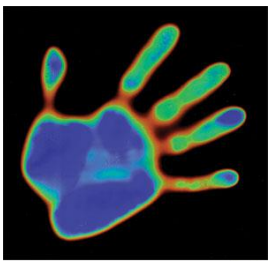
Click a metal disk and watch the liquid crystallize. Younger students can safely feel the heat of a physical change. Advanced students can determine the heat of fusion of hydrated sodium acetate (fp = 54° C). Great for calorimetry experiments! Bending the metal disk initiates the crystallization of super-cooled sodium acetate and water; boiling in water returns the solid to a liquid. Can be used over and over.

3D Pen (CST-400)

Our 3D Pen puts the power of 3D printing right in the palm of your hand. Use it to create nearly anything you can imagine! Endless possibilities for your STEM classroom. Use it to create 2D objects on a hard surface, or create fully 3D objects. Uses eMate polymer filament—a low-temperature (70 ~ 100°C) material—perfect for student use. Comes with pen, charging cable, and 3 meters of eMate filament (color may vary). For more interesting designs, order multi-color refills (5 meters each).

Goldenrod Color-Changing Paper (SM-925)

True goldenrod paper is made from a dye which is an acid-base indicator. This paper turns bright red in bases such as ammonia, baking soda or washing soda and returns to bright yellow in acids such as vinegar or lemon juice. Make your own indicator paper or use to preserve fingerprints. Instructions included. Color-changing goldenrod paper has become very difficult to find. Ours is guaranteed to be color-changing.



Touch and See Square (SS-900)

Place your hand on this black plastic square and create a beautiful thermal handprint. Each color represents a different temperature. Can be used over and over again. Great addition to your 'Hands-on Science Table.'