

Polychromic Polymers

Introduction

Hydrocarbons are materials that are made only of carbon and hydrogen atoms. At room temperature, some of these are solid plastics (e.g., HDPE), some are fluids (e.g., gasoline), and some are gases (e.g., propane). When many carbons are linked together into a chain, they form a polymer. Polymers that can be molded into shapes are called plastics.



In this experiment, you will see that polymers with the same basic ingredients behave very differently from one another when exposed to heat. Crayons are made from wax, which is a polymer chain made of approximately 250 carbons linked together. However, high-density polyethylene (HDPE) has thousands of carbons in its chain, which causes it to behave very differently due to the difference in length of the chains.

Materials

crayons, multiple pieces
milk jug or similar #2 plastic container

muffin liner cups, 2

Equipment

Bunsen burner
oven

scissors
tongs

Safety Considerations

- Be careful not to burn yourself when working with the oven!
- Wash your hands thoroughly after completing this lab.

Procedure A – crayons vs. HDPE

1. Preheat the oven to 95°C (around 200°F).
2. Using a pair of scissors, cut a sample of high-density polyethylene (HDPE) into about 6 pieces (about ½” on each side) and place them into a muffin cup. Label the bottom of the cup with your group members’ names.
3. Again using scissors, remove the paper from two different colors of crayons and chop them into small pieces (no longer than ½”). Label the bottom of a muffin cup and place the crayon pieces inside (it should be about ¼ to ⅓ full).
4. CAREFULLY place both muffin cups in the oven for 4-5 minutes.
5. CAREFULLY remove the muffin cups from the oven and place them on a lab station. Try not to spill anything on the floor!
6. Observe the material in both muffin cups and record your observations in the Data Table. Be sure to record if either substance has melted and what they look like.
7. Let the crayon material cool for about 5-10 minutes and then peel the muffin cup away. You may use your “polychromic polymer” to color on your paper!

Procedure B – HDPE recrystallization

1. Using a pair of scissors, cut a sample of high-density polyethylene (HDPE) into a square about 2-3” on each side.
2. Using tongs, hold the square of HDPE several inches above a Bunsen burner flame and CAREFULLY heat it by moving the square back and forth until it becomes clear. If the plastic sample changes shape or begins to smoke, you are holding it too close!

- Record your observations in the Data Table.

Clean-up

- Dispose of any leftover crayon or plastic pieces in the trash, NOT THE SINK!
- Return all equipment to its proper location.
- Wash your hands before leaving the lab.

Data Table

Polymer	before	after
crayons in oven		
HDPE in oven		
HDPE over flame		

Questions

- Which type of polymer was more durable? Why do you think so?

- Most crayons are made of paraffin wax, the same material used to make candles. Based on your observations, what is it about paraffin's molecular structure that makes it good for use in crayons (as opposed to HDPE)?

- HDPE tubes are often used as launch tubes for fireworks displays. Based on the oven test you performed, why do you think HDPE is used for this?

- What do you think happens to the polymer structure of HDPE when it's heated that causes it to become transparent?

- List one way you could change this lab and describe how your results might be different.
