Growing Spherulite Crystals

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Activity Summary

In this activity, students will be investigating crystal growth at varying temperatures. Students will melt polyethylene glycol and allow it to solidify at different temperature ranges.This activity models the research I performed this summer, which focused on how crystals form from amorphous thin films set at different annealing temperatures.

Audience
High school chemistry

Time Frame
Set-up: 10min
Activity: 30min
Clean-up: 10min

Objective(s)

1. Understand how crystalline solids form.

2. Investigate how temperature differences affect crystal growth.

3. Perform lab skills, including using a hot plate and microscope.

Standards Addressed

Next Generation Science Standards

HS-PS1-3. **Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.** [Clarification Statement: Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.] [*Assessment Boundary: Assessment does not include Raoult's law calculations of vapor pressure.*]

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HS-PS2-6. **Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.*** [Clarification Statement: Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.] [*Assessment Boundary: Assessment is limited to provided molecular structures of specific designed materials.*]

MS-PS1-1. **Develop models to describe the atomic composition of simple molecules and extended structures.** [Clarification Statement: Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of molecular-level models could include drawings, 3D ball and stick structures, or computer representations showing different molecules with different types of atoms.] [*Assessment Boundary: Assessment does not include valence electrons and bonding energy, discussing the ionic nature of subunits of complex structures, or a complete description of all individual atoms in a complex molecule or extended structure is not required.*]

Wisconsin Standards for Science
SCI.PS1.A: Structure and Function

6-8 (m) SCI.PS1.A.m

The fact that matter is composed of atoms and molecules can be used to explain the properties of substances, diversity of materials, states of matter, phase changes, and conservation of matter.

9-12 (h) SCI.PS1.A.h

The sub-atomic structural model and interactions between electric charges at the atomic scale can be used to explain the structure and interactions of matter, including chemical reactions and nuclear processes. Repeating patterns of the periodic table reflect patterns of outer electrons. A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy to take the molecule apart.

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Activity Materials

Polyethylene Glycol 3550 (miralax) , <1g
Polyethylene Glycol 8000*, <1g
Polyethylene Glycol 400*, <1g
Polarized film (50x50mm) (A4 Sheet), 2 pieces of film of at least 50x25mm
Glass microscope slide with cover, 3 sets
Hot plate
Ice water, 250mL, enough to submerge microscope slide
Acetone and dry ice*
Microscope/hand lens
Tongs and/or tweezers
Goggles

* Denotes optional materials

Safety

Safety goggles should be worn at all times throughout the lab activity.

Activity Instructions

Link to student materials

Set-up

Before the lesson, lab stations should be set up including a hot plate, microscope, bowl of ice water and small containers of the polyethylene glycol (1 station per 4-6 students). Other materials may be divided into kits (including 3 microscope slides, 3 cover slips, 2 pieces of polarizing film).

Prior to this activity, students should be familiar with states of matter and using particle pictures to represent different types and states of matter.

Introduction: Pre-lab (10 min)

Before starting the lab, we will briefly review the key concepts of the difference between liquids and solids at the atomic level. Students will read the introduction to the lab and use models of polymers to predict how the crystals will form. Students will also review safe lab practices and read the lab procedure.

Lab Activity (30 min)

Students will follow the procedure to create their polyethylene glycol crystals.
Once students have created their sample crystals at each temperature range, they will analyze their samples qualitatively by describing them when they view them with and without the polarizing film. Then, they will analyze them quantitatively by counting/estimating the number

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of crystals formed on each slide. Students will create histograms that represent their data during the post-lab activity on day 2.

Lab Clean-up/Conclusion Day 1 (10 min)
Studentswill clean their lab stations by returning reusable equipment and disposing of their glass slides in a glass disposal box. They will reflect on their lab performance by answering the following questions: What is one thing that worked well for your group? What is one thing you could have done differently?

Post-Lab Activity: Day 2 (30 min)
Students will complete their data analysis and reflection on the lab in the post-lab activity. Students will begin by comparing their results to their predictions. Then they will create histograms to represent their data. Finally, students will reflect on the lab as a whole and form conclusions that explain their lab results.

Assessment

This lab can be assessed through students' data collection and analysis. In the post-lab activity, students are asked to respond to the following questions.

1. Compare your predicted drawing of the crystal to the ones you observed in the lab. How are they similar or different?
2. What do you think is the underlying arrangement of the particles that formed the crystals you saw in your lab? Draw a particle picture. You may use the PEG molecule models to help you.
3. Create histograms of the data you collected in Table 2. How do the graphs change as the temperature changes?
4. Why do you think the temperature affects crystal growth the way that it does?
5. There are many other factors that affect crystal growth. What else could you change in this experiment that would help you better understand crystal growth?

Background/Prior Knowledge

Students should be familiar with states of matter and phase changes. A useful computer simulation students can use is the Phet States of Matter Simulation that can be accessed with the following link: https://phet.colorado.edu/en/simulations/states-of-matter

Students should also be familiar and have practiced safe laboratory skills, as students will be using hot plates and handling glass materials.

Supplemental Materials

- Student Facing Materials
- Student Facing Materials with Critical Reading

References

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