

Student Worksheet

Turning Fruit Juice into Graphene Quantum Dots

Safety

Hotplates: Use tongs to move hot beakers. Hot liquids: Safety eye-wear required.
Ammonia is irritant to skin. Wear gloves.

Introduction: Graphene, a nanoscale material, is a form of carbon that has potential to be a great material for many uses. Graphene is a one atom thick, two dimensional material which consists of carbon atoms densely packed into a honeycomb-like crystal lattice. It exhibits interesting electrical, optical, mechanical, thermal properties. Electrically, it is a semiconductor. Graphite, used in pencils, consists of billions of graphene sheets stacked atop of each other.

Quantum dots are nanoscale semiconductors which emit light. Unlike many materials used to make quantum dots for fluorescence, such as cadmium selenide, lead sulfide, and indium arsenide, graphene has very low health concerns. Graphene quantum dots are being explored by nanoscience researchers because of their interesting properties such as low toxicity, stable fluorescence, chemical stability, and quantum effect. In fact, a super low-tech method of making quantum dots is to heat citric acid until it carbonizes to make blue-green fluorescing nano-discs. In this activity, you will create such nano-discs. You will take it even more low tech by using fruit juice, not pure citric acid. How will your choice of fruit juice affect the fluorescence of the quantum dots?

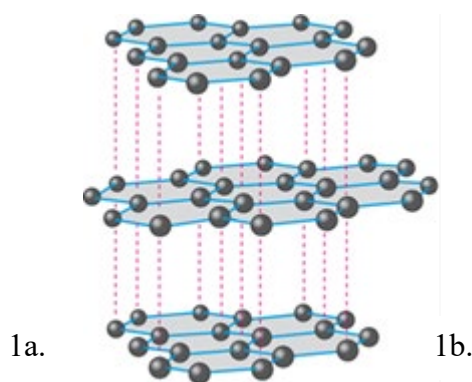
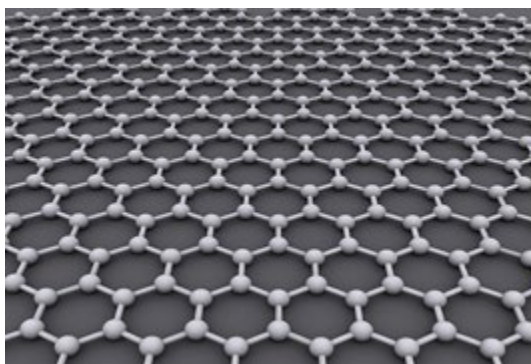


Figure 1a. Graphene from: <https://commons.wikimedia.org/wiki/File:Graphen.jpg>

Figure 1b. Graphite from: http://chemhume.co.uk/ASCHEM/Unit%201/Ch3IMF/Images%203/hexagonal_structure.jpg

Materials per group

- Hotplate
- 2 types of fruit juice
- 2- 50ml Pyrex beakers
- Timer or clock
- Tongs

- Heat-proof mat/surface
- Sodium bicarbonate solution
- syringe
- syringe filter disc
- pipette
- piece of silicon wafer or glass slide
- grease pencil or label
- mesh screen
- marker
- UV light

Directions for the Activity:

Part I. Making Graphene:

You will watch, either in class or as homework, videos on graphene and the tape method to create it from a piece of graphite. Your teacher will supply you with a piece of graphite and clear tape to create your own graphene.

Questions:

1. How successful were you in creating graphene? Based on what evidence?
2. What might improve your ability to make graphene?
3. Do you think a light microscope is the best tool to observe your results?
If not, what tool would you use and why?

Question: Why do you think the choice of fruit juice might affect the fluorescence of the quantum dots produced?

Make a prediction: **Because** _____

I predict _____

Part II. Making Graphene Quantum Dots

Procedure:

1. Turn on your hotplate to 250°C
2. Put 5 ml of fruit juice 1 into a 50 ml beaker and label it well.
3. Put 5 ml of fruit juice 2 into a 50 ml beaker and label it. Put both beakers on the hotplate near the center, cover with the mesh and heat until dryness (about 10 minutes). Carefully watch to avoid burning. Record the time the juices first start to boil. Make observations of what happens to the juice.



4. When the juice has boiled dry, record the time, remove the beakers from the hotplate with tongs and place them on a heat-proof surface and let cool for 1 minute.
5. Slowly add 5ml of sodium bicarbonate solution to each beaker and stir.
6. Extract your samples into a syringe and then fit a filter disc to the end of the syringe. Filter your sample back into the beaker to remove any large particles.
7. Using the pipette, put a drop of your two products side by side on a glass slide. Label which drop is what juice with marker.
8. Observe the drops under ultraviolet light (also called UV or blacklight) in the viewing box.
9. Compare your results with other groups. Does your prediction seem to fit with the observations? Does another group have a prediction that fits better? Do you have a new idea of how to predict the outcome?

Record your observations:

	Start Appearance	Heating Notes	End Appearance	UV Color
Juice 1				
Juice 2				

Analyze the Results:

Because

We predicted.....

Our results show.....



1. Was your prediction correct based on the results and observations? Should you keep or discard your “because” idea?
2. Is there another “because” idea that might predict results better?
3. How would you change the experiment to investigate whether your “because” hypothesis works in a different situation?
4. Why might quantum dots from fruit juice be useful? Be inventive but give your reasons for each use.

