



Bubble Raft Model for Crystal

Overview: In this demonstration / lab students use uniform bubbles floating on water to model the formation and organization of atoms in crystals.

Background: Self assembly is the idea that particles can organize themselves into the complex structures with a high amount of order. Closely packed balls of the same size will eventually sort themselves into tightly packed rows that look like the atoms arranged in crystals. At the molecular level crystals form when atoms align themselves in the position with the lowest energy in response to layers of crystals already in place. It's very hard to see crystals form at the nano-scale. You can see the macro effect of ordered solids in large crystals that mimic the geometry of their smallest. The bubble raft forms a sheet in which each bubble is drawn by surface tension to the closest position. This is analogous to the atomic forces which draw atoms into crystal formations. This model is most analogous to the structure of a metal formed of identical atoms.



Research Connection: Our researcher highly ordered create nano-crystals which interesting properties at the nanometer scale. Defects in the crystals can add to or detract from the useful properties of a nanocrystal.

NGSS Standards: correlates to performance expectation statements and DCI, CCC, SEPs if possible.

Standard Number	Standard text
MS-PS1-1	Develop models to describe the atomic composition of simple molecules and extended structures.

Materials:

- Aquarium pump
- Blunt syringe tips
- Valves
- Clear tray
- Dish soap
- Glycerin or corn syrup

Procedure:

1. Connect a blunt syringe to a hose to the aquarium pump and fix it to the side of plastic tray so that it sit near the bottom.

2. Mix up a bubble solution with 2 cups hot water, $\frac{1}{4}$ cup dish soap and 2 tablespoons of glycerin.
3. Fill the tray with soap solution to $\frac{1}{2}$ inch from the top.
4. Turn on the pump and regulate the pressure until you have steady stream of uniform small bubbles.
5. Observe the pattern of bubbles. What crystal structures do you recognize

Discussion

What happens if you mix bubbles of different size? **There is no organization.**

What force is causing the bubbles to stick together? **Surface tension around each bubble**

What is the effect of a **defect** caused by introducing a single larger bubble? **Other bubbles have to adjust.**

Can you see crystal domains or grain boundaries? You may see portions of the bubble raft that aligned in one direction colliding with another set in another direction. This happens when crystals grow from more than one front at the same time and run into each other.

Can you create an ordered lattice with more than one size of bubble? **Very carefully create two size of bubble right next to each other.**

Extensions: Experiment with different size bubbles. Try using two tips which produce two different size bubbles at the same time. Try making a time laps movie of your bubble raft formation using the Lapse it smart phone app.

Resources: provide student worksheets or readings as separate document and provide name here.

Sources: where to get materials- specific catalog or online entries if possible

<http://homepages.cae.wisc.edu/~stone/bubble%20raft%20movies.htm>

<https://pubs.acs.org/doi/pdf/10.1021/ed052p521.1>

<https://www.youtube.com/watch?v=v8KYZHMKTHw> bismuth

<https://www.youtube.com/watch?v=dT1U7qeTj64> sodium acetate

Sources

[Bstean Syringe Blunt Tip Needle and Cap - 10ml, 5ml, 3ml, 1ml Syringes 14ga 16ga 18ga 20ga Blunt Needles - Oil or Glue Applicator \(Pack of 10\)](#) \$7.89

[Pawfly MA-60 Quiet Aquarium Air Pump for 10 Gallon with Accessories Air Stone Check Valve and Tube, 1.8 L/min](#) \$8.99

[InterDesign Clarity Kitchen Drawer Organizer for Silverware, Spatulas, Gadgets - Medium, 8" x 8" x 2", Clear \(49640\)](#) \$11.53

[Glycerin USP Ointment, 6 Fl Oz, Pure, Natural, Vegetable Based](#) \$3.88