

# Imaging a Gumball Atomic Surface

## Modeling a Scanning Tunneling Microscope

### Background Information:

A scanning tunneling microscope is used to trace the surface of atoms. Using a small tip so sharp that the end is a single atom, the microscope takes advantage of the fact that quantum tunneling causes electrons to tunnel, or jump, from the atom in the surface to the atom in the tip. This movement of electrons creates a current that is measured and turned into a pixel. The closer the tip is to an atom, the higher the current, and the lighter the pixel. The farther the tip is from an atom, the lower the current, and the darker the pixel. Eventually these pixels form an image that shows the location and shape of atoms in a material.

### Purpose:

To model how a scanning tunneling microscope images using a gumball atomic surface.

*To be done in groups of 2 or 3*

### Materials:

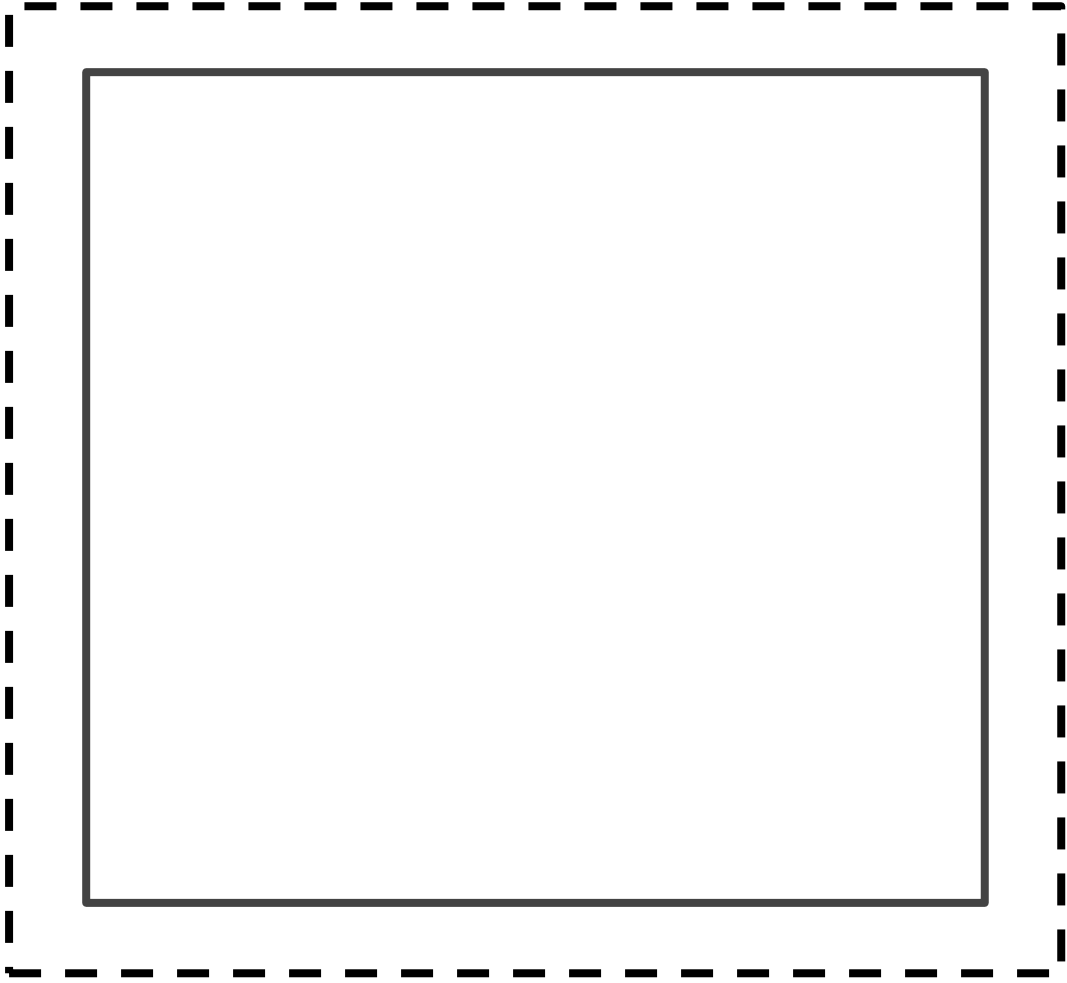
- Gumballs
- Paper cutout
- Compass
- Graph paper
- Pencil
- Clipboard
- Scissors
- Tape

### Procedure:

1. Cut out and fold your paper container. Tape the corners together so that the box stays standing.
2. Fill the bottom of the container with one layer of gumballs. Make sure the container is on a flat surface.
3. Attach the graph paper to the clipboard.

4. Have one person hold the clipboard steady and upright next to the container. It should be far enough away from the board that it can be drawn on according to the following steps:
5. Carefully place the sharp end of the compass on the gumball in the corner of the container closest to the clipboard.
6. Raise the pencil part of the compass up so it makes a  $90^\circ$  angle and rest the pencil against the graph paper.
7. Carefully move the pencil along the first row of gumballs. You do not have to press down hard on the gumballs, barely touching the tip of the compass to the top of the gumballs to get a rough estimate of the size and position.
8. After completing the row, move the graph paper or the entire clipboard up so that the next row of gumballs will not overlap with the other rows.
9. Repeat steps 7 and 8 for a minimum of 4 rows of gumballs.
10. Once all the lines are drawn, mark the peaks in each row (where the tops of the gumballs are)
11. To the best of your ability, draw circles around each of the peaks roughly the size of the gumballs to best represent the image that an STM can make.

You have now made a picture of your 'atomic' surface!





<links to videos>

Bios:

Elizabeth:

Hi! I'm Elizabeth, I'm 18 years old, and I am looking into science as a career. I hope you enjoy this experiment!

Laura:

Hi! My name is Laura, I'm 18 years old, and I am looking into a career of secondary education. This experiment was a lot of fun to design and I hope you all enjoy it!