# You Can Eat Crystal and Glass??

**The same, but different:**

These two lollipops look and feel very different. Why are they so different if they're made out of the same stuff - sugar?

It has to do with how they are made. The rock candy on the right slowly formed crystals from sugar dissolved in water. The sugar molecules are in an organized pattern. The lollipop on the left was made from sugar solution heated to about 300 °F. It cooled so quickly from the liquid that there was no time for crystals to form, and the sugar molecules are all jumbled up. A solid material without crystals is called ***amorphous,*** or *glass*, and one with crystals is called ***crystalline*.**

**Which lollipop is *glass*, and which is *crystalline*?**

In these activities, you will explore the differences between amorphous and crystalline materials by making edible glass and crystals.

**Activity: Edible Glass**

*Time: 45 minutes. Parents, please supervise children.*

**Materials:**

- 1 ½ cups sugar
- ¾ cup water
- ½ cup light corn syrup
- 1 tsp. extract or oil flavoring
- Food coloring
- Confectioner's sugar
- Saucepan
- Large wooden or plastic spoon
- Measuring cup
- Candy thermometer
- Baking sheet

**What to do:**

- Spread a layer of confectioner's sugar onto the baking sheet.
- Mix water, sugar and corn syrup in the saucepan on medium heat until the sugar is dissolved.
- Boil on medium heat, checking the temperature every so often until the mixture reaches 300 °F. This will take several minutes.
  *Be very careful with the hot sugar solution.*
- Remove from heat. Mix in flavoring and food coloring.
- Pour onto the baking sheet.
- Sprinkle more confectioners' sugar on top.
- Wait until candy is completely cooled and break into pieces.

**Extension Activity:**

- Instead of pouring all the sugar mixture onto the baking sheet, pour some into a bowl of ice-cold water. The mixture will cool even more quickly, causing some really neat things to happen!

**Activity: Edible Crystals**

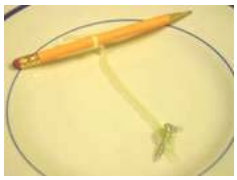
*Time: 45 minutes and a few days wait time. Parents, please supervise children.*

**Materials:**

- 2 ½ cups sugar
- 1 cup water
- Food coloring
- Saucepan
- Large wooden/plastic spoon
- Measuring cup
- Small glass jar
- Piece of cotton string
- Pencil
- Plastic wrap
- Clean washer or screw
- Plate

**What to do:**

- Heat water in saucepan over medium to high heat until it boils.
- Add sugar, and stir until liquid is clear and reaches a rolling boil.
- Remove from heat. Add a few drops of food coloring.
- Carefully pour sugar mixture into jar.
- Tie washer or screw to one end of string, and tie the other end to the pencil. Dip string in sugar solution and take it out again. Lay string on plate. Leave out to dry overnight, then proceed to the next step.



- *Why am I letting the string dry?*
    - *Letting the string dry on the plate allows little sugar crystals to grow. It is on these little crystals that the big sugar crystals will grow.*
- Lower string into jar until pencil rests on top. Loosely cover the top with plastic wrap so dust stays out, but water can evaporate.
- Leave someplace cool and out of the way. Don't move it for several days.
- When the crystals are big enough for your taste, eat the results!

***Question:*** *Observe the candy you have made, using your 5 senses. How are the properties of crystalline candy and glass candy the same? Different?*

**Extension Activity:**

Make rock candy with flavoring, or glass candy without flavoring for a more direct comparison. Are flavoring and coloring incorporated differently into the two types of candy?

**Connection to Nitinol:**

The organized structure of the atoms and molecules in a material give it its properties. Nitinol has two different organized crystal structures, or ***phases***. When it is in one crystal structure, it is soft and bendable, and in another crystal structure, it is stiff and springy. Similarly, sugar candy can have two different structures. The difference is that one type of candy has an organized structure, and the other type of candy is not organized at all.

**Did you know?**

Nitinol isn't the only material that has more than one crystal structure. Diamond and graphite (pencil lead) are two different phases of carbon. Steel and water ice both have many solid phases with different properties.

**For More Information**

- Lollipops.
  http://www.candyusa.org/Candy/lollipops.asp

- Nitinol Information, from the Images SI, Inc. website:
  http://www.imagesco.com/articles/nitinol/01.html

- What's that Stuff? Glass. By Victoria Gilman.
  http://pubs.acs.org/cen/whatstuff/stuff/8147glass.html

- Metal Makeover. By Peter Weiss.
  Science News. Nov. 6, 2004. Vol. 166 No. 19, pages 298-300.

**Vocabulary**

***Amorphous:*** Having no organization or crystal form.

***Crystal Structure:*** The organized arrangement of the atoms within a material.

***Crystalline:*** Having an organized arrangement of atoms.

***Glass:*** Materials that become solid without forming an organized crystal structure.

***Phase:*** Any of the states in which matter can exist.

***Nitinol:*** An alloy of Nickel and Titanium that returns to its previous shape when you heat it.

**References:**

Science of Cooking: Rock Candy http://www.exploratorium.edu/cooking/candy/recipe-rockcandy.html

Teaching General Chemistry: A Materials Science Companion. Arthur B. Ellis, Margret J. Gesselbracht, Brian J. Johnson, George C. Lisensky and William R. Robinson. Published by the American Chemical Society, 1993.