

NRELEd: Crystal NREL Signs

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Background

Crystals are often associated with mythical sciences. For hundreds of years, humans have believed that natural crystals have healing powers. These crystals are usually made of minerals like quartz (SiO_2) and come in many different shapes and colors. Everyday compounds like salt (NaCl) and sugar ($\text{C}_6\text{H}_{12}\text{O}_6$) are crystals. Water in its frozen form, ice, forms a crystal. If you have ever caught a snowflake on your hand on a snowy day, you have probably seen an ice crystal.

While the magical properties of crystals have never been proven, crystals have many useful properties that scientists use. Crystals are made up of a predictable pattern of elements. This allows scientists to understand how light or electricity will interact with the solid.

Silicon is an element that is used in most solar cells today. Scientists use very small seeds of raw silicon to grow large crystals (like [this](#)) that are then cut into slices for use in solar cells. Think of it like an icicle: water drips down and freezes, and as more water drips down, the icicle gets bigger with the same shape, growing around the original seed of ice.

Crystal NREL Signs

Design an NREL sign. You are welcome to save your sign, and have it displayed in the NREL Education Center when you come to campus. You can also [submit a picture](#) of your sign to be displayed if you can't bring it in.

What you need:

- Pipe cleaners (10-15)*
- String
- Borax
- Boiling water
- Several different food colorings
- A glass for each color dye
- A pencil
- Glue
- Sheet of computer or construction paper

*If you do not have pipe cleaners, you may be able to substitute yarn. Use either glue or wire to help your yarn hold its shape.

Procedure:

2nd Grade and below: Create a Crystal NREL Sign

1. Shape the pipe cleaners into the letter 'N' 'R' 'E' 'L'
2. Attach a 10" string to each of the letters.
3. With a parent's help, bring water to a boil.
4. Add 6 tablespoons of borax into a glass. Have a parent pour in two cups of boiling water (it can cool a little)
5. Add five drops of food coloring into the glass.
6. Repeat steps 4 and 5 for as many colors as you would like.
7. Dip your letter into the glass, taping the string to the top of the glass.
8. Let them sit for 12-24 hours (usually overnight).
9. After letting the crystals grow, pull them out and let them dry.
10. Glue or tape your letters onto your sheet of paper and draw with markers around it to create a new "Welcome" sign for NREL!

3rd-5th Grade: Create a Crystal Ed Center Sign

1. Shape the pipe cleaners into the letter 'E' 'd' 'C' 'e' 'n' 't' 'e' 'r'.
2. Attach a 10" string to each of the letters.
3. With a parent's help, bring water to a boil.
4. Add 6 tablespoons of borax into a glass. Have a parent pour in two cups of boiling water (it can cool a little)
5. Add five drops of food coloring into the glass.
6. Repeat steps 4 and 5 for as many colors as you would like.
7. Dip your letter into the glass, taping the string to the top of the glass.
8. Let them sit for 12-24 hours (usually overnight).
9. After letting the crystals grow, pull them out and let them dry.
10. Glue or tape your letters onto your sheet of paper and draw with markers around it to create a new "Welcome" sign for Ed Center!

6th Grade and higher: Create a Crystal Sign for NREL director Martin Keller, PhD

1. Shape the pipe cleaners into the letters for Martin Keller, PhD.
2. Attach a 10" string to each of the letters.
3. With a parent's help, bring water to a boil.
4. Add 6 tablespoons of borax into a glass. Have a parent pour in two cups of boiling water (it can cool a little)
5. Add five drops of food coloring into the glass.
6. Repeat steps 4 and 5 for as many colors as you would like.
7. Dip your letter into the glass, taping the string to the top of the glass.
8. Let them sit for 12-24 hours (usually overnight).
9. After letting the crystals grow, pull them out and let them dry.
10. Glue or tape your letters onto your sheet of paper and draw with markers around it to create a new sign for Martin Keller!

The Science!

Making crystals is all about the solution. A solution is made up of a solvent (the substance doing the dissolving) and the solute (the substance being dissolved). In this lab, water is the solvent and borax is the solute. Hot liquids are able to have more solids dissolved in them, which is why we heat the water. The boiling water can dissolve 3 tablespoons of borax. However, as the water begins to cool, the borax crystals no longer want to stay dissolved. The [solution](#) is supersaturated. The fibers of the pipe cleaner (or yarn) act as the seed for the borax to start forming crystals. As the water continues to cool, more and more crystals need somewhere to go. They are attracted to the crystals on the pipe cleaner, and this process continues until you have the beautiful crystal letters that you see.

[Silicon](#) is the most versatile semi-conductor available. It can be found in televisions, cell phones, computers, and beyond. At NREL, we use silicon in solar cells to absorb sunlight and convert it into electricity. Large crystals of silicon are made using a very similar process to this experiment with borax—a small seed crystal is dipped into liquid silicon, and then slowly removed so that a long crystal is formed as the liquid silicon cools into a solid.