



## Polymer Activity from the:

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### Atlanta NSTA "Make and Take" Activity: April 2004

#### Ghost Crystals and Mystery Messages

**Grades:** Middle to High School

**Science Standards:** Content Standard B: Physical Science; Content Standard E: Science and Technology

##### A. Ghost Crystals

These are crystals of polyacrylamide that have been hydrated (water's been added). They swell as they absorb water. Polyacrylamide is sold in garden stores (Soil Moist<sup>®</sup>, Crystal Soil<sup>®</sup>, Terra-Sorb<sup>®</sup> and other brands) as a conditioner to hold water in potted plant soil. It will slowly (in 6 to 12 hours) absorb from 40-200 times its weight in water. Thus it keeps soil more uniformly moist for longer periods of time after watering,. As the soaked crystals slowly release their moisture back into the soil. Because the hydrated crystals are almost entirely water, they essentially "look" like water. Light does not bend as it passes from water into the crystal so the crystals are almost invisible in water.

Procedure to make ghost crystals:

1. Pick out several of the largest dry crystals you can find.
2. Place them in water and allow them to fully hydrate (6-12 hours).
3. Pick out one large hydrated crystal.
4. Gently tie a piece of yarn or thread around the crystal. If you wish, push a toothpick through the center of the crystal to suspend it by the thread in a cup of water.
5. Store the crystal in a small, clear jar of water.
6. The crystal is invisible in the water.

##### B. Mystery Messages

1. Write a short message, backwards (mirror-writing) on one side of a clear bottle, or zip-top plastic bag.
2. Cover the message with an opaque label. Or, write directly on the **back side** (sticky side) of the label.
3. Put about one teaspoon of dry polyacrylamide crystals into the bottle or bag for each liter of volume.
4. Add water. It will take 6 to 12 hours for the crystals to fully hydrate, although you will see them begin to grow almost immediately.
5. Drain off any excess water. Your message will be obscured by the individual crystals and the air trapped between them.
6. Add "developer" ( WATER! ) and the message will be visible. (You might need to jostle excess air bubbles out of the way. You might also have to remove some of the crystals the first time you hydrate the crystals, if they are packed too tightly.

Here's an alternate method of "developing" the message. This method takes some practice, but it's less messy than adding and pouring off water each time - because the bottle and material is self-contained.

Steps 1-4 above remain the same.

5. Do **not** drain off the excess water. Instead, shake the bottle vigorously (or use your wrist to give it a rotational motion) to see if that motion separates the crystals and adds air back between them. If this works, the message should become "hidden". If not, then drain off just a little water. You may also need to remove some crystals; they should not be tightly packed.
6. After you have shaken the crystals apart, the message will be obscured.
7. Then tap the bottle on the table or, holding it by the top, shake it as if you were throwing it – but don't let go! This should force the water to the bottom of the bottle, filling in the air pockets and making the

message visible. Keep the tube vertical as you read the message, otherwise the air bubbles will appear again and hide the message.

8. You may need to adjust the amount of water, or the amount of polyacrylamide to make the bottle perform as desired. For this method to work, you need a little bit of "head" space at the top of the tube.
  - a. If you **can't hide** the message, you may have **too much water** (or too little air space at the top). This will make obscuring the message difficult (it will be visible all the time – no "mystery"). Try pouring off a little water. Too little polyacrylamide may do the same thing.
  - b. If you **can't see** the message, you may have **too little water**. This will not allow the air pockets to fill in with water, and the message will never be visible (always a "mystery"). You may also have too much polyacrylamide. You need room at the top of the bottle so you can shake the crystals loose from one another so they bend the light. You also need that room so they can reposition themselves to allow the water to fill in the cracks as it settles to the bottom of the tube.

I've given you about 28 grams (roughly 1 ounce) of polyacrylamide in the preform. This is enough to make more than 1 liter of hydrated crystals. Pick out the biggest dry crystals to use for ghost crystals; use the rest for secret messages.

**Note:** Pour crystals **from** the tube to use them. Do **not** fill the tube with water while the crystals are still inside. There is way too much polyacrylamide in the tube to hydrate effectively. Basically, you won't see anything happen inside the tube. The crystals need room to "grow".

You can use the preform to make your first secret message. After that, any flat (or not so flat) transparent bottle or zippered plastic bag will work.

**CAUTION:** Mold may grow on the polyacrylamide over time if it is left hydrated. Keeping the bottles sealed will slow mold growth. Also, you can dry the crystals - either by leaving them out, exposed to the air for several days, or by placing them in a low temperature oven. Once dried, they will not get moldy, and they can be reused over and over again.

It would be best if students did not handle the hydrated crystals, but this might be difficult to enforce. If they do touch the crystals, it is always prudent to have students wash their hands after touching any chemicals.

### C. **Grow Creatures:** Dinosaurs, Beasts, Brains and others

1. These interesting novelties have great possibilities for classroom activities modeling the process of science; observation, data collection and graphing [mass v time], making hypotheses, following a time sequence, drawing conclusions . . .
2. These creatures are made up of two polymers: polyacrylamide [which absorbs a tremendous amount of water] and a copolymer of ethylene and vinyl acetate [which forms a scaffolding to maintain the original proportions and retains the coloring agents]. The toys can be dried out and rehydrated over and over again.
3. Do not try and speed up the swelling by heating the water. The creatures will dissolve!
4. Optional - See if the hydrated creatures will shrink in saturated sugar [messy!] or salt solutions.

Grow creatures can be purchased from most toy stores, or from Flinn Scientific or Educational Innovations and other science supply companies.

### POLYACRYLAMIDE STRATEGY to try with young children.

In advance you have prepared several small bottles that you have written secret messages on. Allow the polyacrylamide crystals to hydrate at least 12 hours and then drain off as much excess water as possible. Pass around the bottles, saying,

"I found these bottles addressed to you students. They seem to have some messages written on them, but I can't read them. Can any of you read them?"

Hopefully, the message will be obscured by the refraction of light as the rays pass from air to crystal many times.

Let them try reading the messages – but not for too long or they may eventually figure them out without actually "reading" the messages.

"Oh, I think I forgot to add the DEVELOPER to the message. Here it is."

With a flourish, pour some water into the bottles. Tap the bottle a few times on the table top to cause the bubbles to rise to the surface, and the message magically "develops". Pass around for the students to read. Statements might include phrases such as SMILE, SCIENCE IS COOL, YOU ARE SO COOL, I'M GLAD YOU'RE HERE, etc.

My thanks to Lynn Higgins, Illinois Polymer Ambassador, for her original write-up on ghost crystals and secret messages, and for her teaching strategy above.

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