Polymer Strength Laboratory: Al DeGennaro

Teacher's Guide

Goals

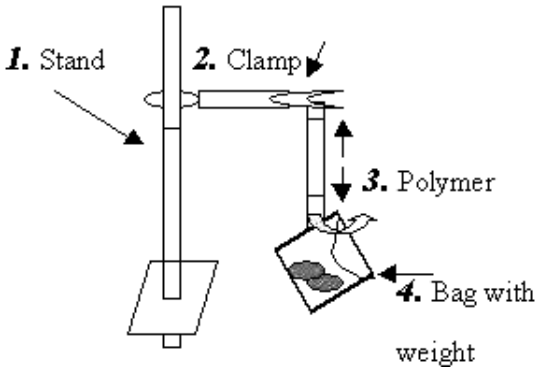
- To learn about the properties of polymers
- To let students experiment on their own and materialize concepts

The Laboratory

In this laboratory, students measure the strength of two polymers Handy Wrap and Saran Wrap, by hanging different weights on it and measuring the stretching that results. The apparatus used to measure is described. Students investigate freely by trying different cuts through the polymers.

Materials for Each Group

- The measuring instruments:



Preparing the Measuring Apparatus

a. Cut a piece of polymer.

b. Cover the edges of the polymer with duct tape.

c. Measure the length of the polymer piece and mark it.

d. Hook it on one end to a clamp.

e. On the bottom end, hang an open ring hook.

f. Tape some duct tape to the corner of a ziplock bag.

g. Make a hole through it.

h. Hang it on the ring hook which is fastened to the edge of the polymer.

i. Put tire weights inside bag and measure the polymer again.

j. Do it for different polymers and for different directions of cutting within the same polymer (see below).

SAFETY

There are no special requirements. All materials used are safe.

Lecture Notes

The purpose of the lesson is to think back to polymers, the little video clip that you watched yesterday. You will notice that there are chains in polymers, and we are attempting to figure out which way those chains go.

I have a little model to show that: I have here about five or six pieces of twine a lot like a string, if you have a string which is all twisted together.

It's pretty strong, when we pull it in a longitudinal direction. If you pull it very hard, it will break. But, it is relatively easy to pull a strand apart: if you play with when you are bored, you can completely unravel it, if you pull it sideways.

Now, in order for it to stretch, lengthwise, the strands have to slide between each other. But they don't want to do it in that twine, because there are little fibers which are attracted to each other.

If I had slippery things, then they would be more likely to slide. But that's why it stretches in one direction, much better than it does in the other.

Today we are going to compare polymers. I have a small piece of plastic wrap, with duct tape on each end. There are two marks, which are exactly 10 cm apart. I used a ruler to mark them.

What we are going to do is to measure how this plastic wrap changes when we add weights at the end.

The apparatus for this is actually an invention, here at Westminster High school, I don't know if it is used anywhere else.

I have here a small metal hook, I have a ziplock bag that has duct tape, and a hole punched through it. The weights that we are going to use are weights that you have used before, the tire-weights.

If you put a tire-weight in the bag very carefully, such that you don't yank it downwards, and let it hang, it might stretch the plastic, or it might not.

You are going to test two kinds of wrap: one is a Handy Wrap, and one is a Saran Wrap.

Saran Wrap is stronger.

You have some serious stretch, do you need a meter stick?

Teaching Tips From Mr. DeGennaro

The people who are actually taking science with the idea of pursuing a science career are few and far between. My more challenging target is the other 80% of students who will never study science in college.

I have to convince those students that science is valuable, not only to society, but also that it is valuable for them personally.

This is something that they can actually test. That's a product that they have seen before. It's not some chemical name that I have written up there that they have never heard of. It's not some jar of chemicals that they have never heard of. That's some product that they have. And what some of them have probably thought of is whether one kind is better than the other.

This lesson went great, it's difficult to predict what students will get totally engaged in. But in each class, I would say that every single kid was focused on what was going on.

They were improvising: they solved their own problems. Some kids had the stands, with books on it, and some kids holding it, kids crawling around on the floor. My feeling at that time was that I had to stay out of it.

Other than walking around and seeing who is comprehending and who isn't, I don't want to change what they are doing. Even if they are not technically following the directions, they are doing their own science in their own little world, and that is so much more valuable than me lecturing to them on what is important.

Students' Reflections

For extra credit we tested Saran Wrap and Handy Wrap, and we did it because we wanted to test bonds, if we could manipulate the way of bonds, or we could change the way that they are going… the bonds either go up and down or they go sideways.

We found that if you cut it one way and the bonds are going up and down- it would stretch, and if you cut it the other way, and the bonds are going side to side, then it would be very strong.

In class, the clear wrap could only support 10 ounces, but when we cut it vertically, it held about 44 ounces so it tripled the amount that it could hold.

At first I didn't really understand why it was doing that, because we only did one day on polymers. But then, once we did this, I saw that if you cut it one way, and then you cut it in a different way, it made a really big difference, and once I saw that, I really understood it then.

References: Links

http://www.chemheritage.org/EducationalServices/faces/teacher/poly/activity/physprop.htm

http://www.chemheritage.org/EducationalServices/faces/teacher/poly/home.htm

References: Readings

Kim, A., and Musfeldt, J.L. (1998) "Understanding Chemical Structure/Physical Property Relationships in Polymers Through Molecular Modeling and Thermal Analysis Techniques," *Journal of Chemical Education,* Vol. 75, No. 7, pp: 893-897.