

[SQUEAKING]

[RUSTLING]

[CLICKING]

**CAROLYN JONS:** This is Goodie Bag number nine. In today's video, we will be exploring the topics of polymerization and cross-linking and learning how these processes can be used to make slime at home. You'll need gloves, Elmer's glue, borax powder, plastic cups, and spoons for stirring. One product made of polymers that many people are familiar with is Silly Putty.

Silly Putty is made of a polymer called polydimethylsiloxane. Polydimethylsiloxane is made of repeating units called monomers that include a silicon, an oxygen, and two CH<sub>3</sub> groups. Today we're going to make an alternative material that behaves a little bit like Silly Putty, but is instead made of a different polymer. This can be made by combining Elmer's glue and cross-linking with borax.

As you can see, after I added borax to the Elmer's glue, the material became much more viscous. This is because of cross-linking. Cross-linking is forming a bond to link one polymer chain to another. In this experiment, the polyvinyl alcohol and Elmer's glue forms hydrogen bonds with the boric acid. These cross-links make it more difficult for the polymer chains to slide past one another, so the material becomes more viscous. By adding in more borax, we increase the number of cross-links, and this results in a material more resistant to flow.

You may have noticed that when we pull quickly, the slime breaks in half. But when we pull slowly, the slime is able to stretch. This is because the slow pulling allows hydrogen bonds to break and then reform, allowing the chains to more easily slide past one another.

In this Goodie Bag, we hope you had an opportunity to make a polymer of your own and witness how cross-linking can change material properties.