

SILLY PUTTY SCIENCE

(Dr. Mark R. Marten, 2006)

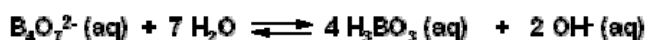
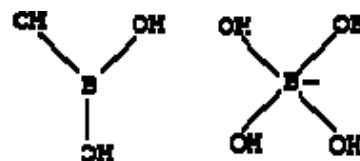
General Explanation:

A polymer is a very long chemical made up of repeating little chemical units all hooked together in a very long chain. Glue contains a polymer called polyvinyl alcohol (PVA). When you add borax solution to polymers like PVA, it cross-links or connects two polymer chains together. When many chains are connected it becomes like a net or a spider's web. The corn starch acts as a filler in the net.

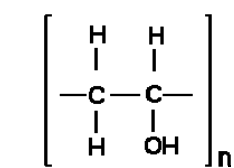
Depending on how much of each ingredient that you mix together, you can make something that is "goopy", slimy, or stretchy. For instance if you add more cornstarch, you will be able to bend and stretch the mix. Add less borax and you will get a "goopy" mixture. To make a slimy substance, add less borax or more glue.

Polymer Chemistry:

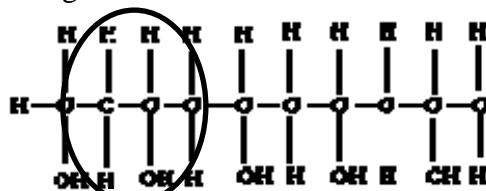
Borax is sodium borate ($\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$). As shown below, borax actually dissolves to form boric acid, H_3BO_3 . This boric acid-borate solution is a buffer with a pH of about 9 (basic). Boric acid will accept a hydroxide OH^- from water. Structures shown to right.



Poly vinyl alcohol is made up of a many vinyl alcohol subunits connected in a chain. The chain can be hundred or thousands of subunits long.

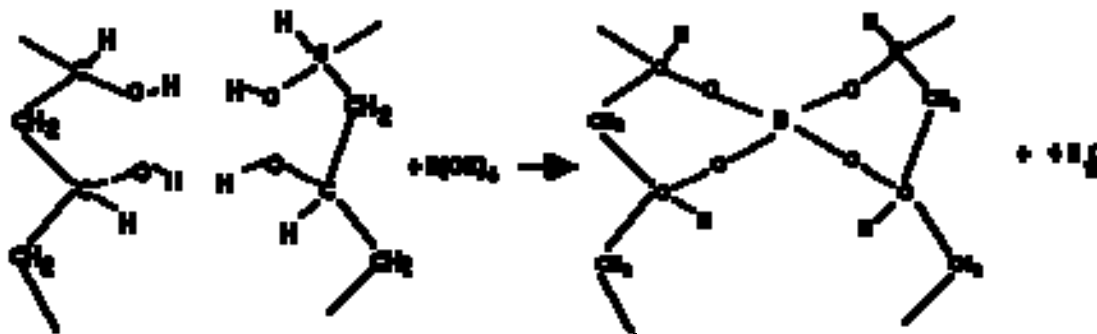


vinyl alcohol subunit



poly vinyl alcohol (subunit circled)

When PVA is mixed with borax in water, the boric acid will act to crosslink the PVA polymer:



Text & Images Sources:

- American Chemical Society (http://acswebcontent.acs.org/celebrate_chemistry/cc_bouncing_ball.pdf).
- Materials Science and Technology Teacher's Workshop, Department of Materials Science and Engineering, University of Illinois Urbana-Champaign (<http://matse1.mse.uiuc.edu/~tw/polymers/e.html>).
- Hyun, et al., J. Non-Newtonian Fluid Mech. 107 (2002) 51-65.