**Cross linked PVA**

PVA glue contains a polymer. PVA is runny.

Mixing borax solution with PVA solution adds cross links to the polymer.

**Predict**

How will the properties change when borax is added to PVA solution?

Write down your **prediction**.

**Explain**

Write down the thinking behind your prediction.

Eye protection

**Gloves**Follow the instructions provided by your teacher to mix a suitable volume of borax solution with 40cm3 of PVA solution.

Wear eye protection and protective gloves if handling the material made.

**Observe**

Test the properties of the material made.

Describe how its properties are different to the PVA solution.

**Explain**

Was your prediction correct?

If not, can you explain what you observed?

*Chemistry > Big idea CMS: Materials science > Topic CMS2: Designing materials > Key concept CMS2.1: Polymer properties*

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| --- |
| **Response activity** |
| **Cross linked PVA** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | Materials scientists can design polymers with specific properties. |
| Observable learning outcome: | Explain how cross links between polymer molecules affect the properties of a polymer. |
| Activity type: | PEOE |
| Key words: | Property, polymer, cross links |

This activity can help develop students’ understanding by addressing the misunderstandings revealed by the following diagnostic question:

* Thermoset plastic

**What does the research say?**

A paper (Cooper, Williams and Underwood, 2015) cited research that about a quarter of grade 12 students (U.S.) thought that intermolecular forces occurred within a molecule.

Another paper (Nakhleh, 1992) reports that some students are not aware of the general difference in magnitude that exists between the strength of a covalent bond and an intermolecular force.

If students have learnt that cross links are stronger than forces between molecules, then they should be able to make links between this feature of the structure and the resulting properties.

**Ways to use this activity**

Students should complete this activity in pairs or small groups, and the focus should be on the discussions. It is through the discussions that students can check their understanding and rehearse their explanations.

To begin, each group should discuss the activity and use their scientific understanding, firstly to predict *what* they think will happen, and then to explain *why* they think they are going to be right. If students in any group cannot agree, you may be able to direct them with some careful questioning.

Students now carry out the practical or watch a demonstration. You will need to decide whether it is better for each group to carry out the practical and risk some unexpected observations, or to demonstrate the activity so that everyone *observes* the same thing.

After the practical each group should be given the opportunity to change or improve their explanation. A good way to review your students’ thinking might be through a structured class discussion. You could ask several groups for their *explanations* and put these on the whiteboard. Then ask other groups to suggest which explanation is the most accurate and the most clearly expressed, and through careful questioning work up a clear ‘class explanation’.

A useful follow up is for individual students to then write down explanations in their own words – without reference to the class explanation on the board (i.e. cover it up).

*Differentiation*

The quality of the discussions can be improved with a careful selection of groups; or by allocating specific roles to students in each group. For example, you may choose to select a student with strong prior knowledge as a scribe. They may question the others and only write down what they have been told. This strategy encourages contributions from more members of each group.

**Equipment**

For each student/pair/group:

* Eye protection
* Disposable plastic gloves
* Measuring cylinder (50 cm3)
* Plastic cup
* Plastic stirring rod
* Borax solution
* PVA Solution

**Technician notes**

Please see <https://edu.rsc.org/resources/pva-polymer-slime/756.article> for full details.

**Health and safety**

Please see <https://edu.rsc.org/resources/pva-polymer-slime/756.article> for safety advice.

Practical work should be carried out in accordance with local health and safety requirements, guidance from manufacturers and suppliers, and guidance available from CLEAPSS.

Please note that not all methods of making slime that are found online are safe.

**Expected answers**

Students should predict that property should change from being runny to being less runny or stretchy.

**Acknowledgments**

Developed by Peter Fairhurst and Helen Harden (UYSEG).

Images: Peter Fairhurst (UYSEG)

**References**

Cooper, M. M., Williams, L. C. and Underwood, S. M. (2015). Student understanding of intermolecular forces: A multimodal study. *Journal of Chemical Education,* 92**,** 1288-1298.

Nakhleh, M. B. (1992). Why don't some students don't learn chemistry. *Journal of chemical education,* 69(3)**,** 191-196.