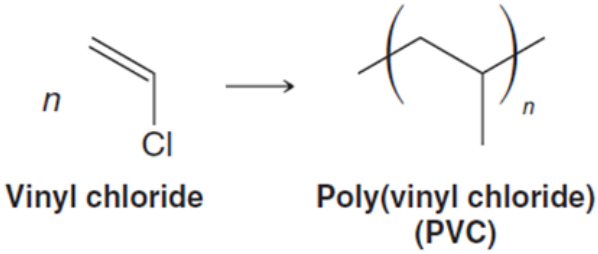
THE SCIENCE OF POLYMER CLAY

Polymer clay is a great art medium - it's also a great example of science creating art. Artists create polymer clay art, but chemists made the clay! Polymer clay actually contains no natural clay. You can't find it in nature. It is created from man-made chemicals in such a way to have the characteristics that artists want in a polymer clay. Polymer clays are basically made from **PVC (polyvinyl chloride)** and a **plasticizer**. **PVC** is a type of rigid plastic that's used in a variety of applications, namely construction (do PVC pipes ring any bells?).

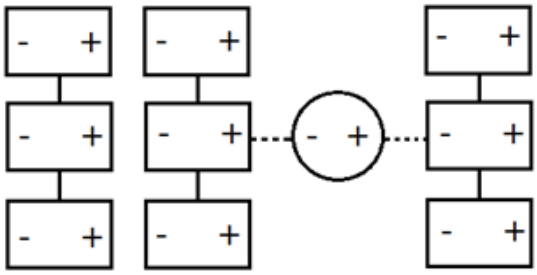
Adding a **plasticizer** makes the PVC more flexible. Most polymer clays use a class of chemical called phthalates as a plasticizer. When the PVC is mixed with the plasticizer, the substance is called a **plastisol**. Other substances are added to the plastisol to hold it together and give the polymer clay its other characteristics, such as color. So, polymer clay is essentially a moldable plastic.

PVC is synthesized in a chemical reaction called **radical chain polymerization** from its monomer (basic building block), **vinyl chloride**.



The little "n" indicates that there are a bunch of vinyl chloride molecules (which are monomers) connected together in order to make the larger polymer, polyvinyl chloride (PVC).

The reason why plasticizers make polymer clay soft is simple, and has to do with how plasticizer molecules interact with PVC molecules. Between molecules, attractive and repulsive forces exist. The attractive forces bring the molecules closer together, and the repulsive forces push them apart. The forces between molecules are called intermolecular forces. The reason why plasticizers make PVC soft is because the plasticizer molecules fit in between the PVC molecules, preventing them from having strong attractions to one another. (These attractions are based on charges - opposite charges attract, and same charges repel.)



The circle represents the plasticizer molecule, and the rectangles represent PVC molecules. The pluses and minuses represent electrostatic charges, which attract and repel each other. The plasticizer molecule interferes between the strong electrostatic forces between the individual PVC molecules, which means that the PVC molecules are less packed together. As a result, the overall PVC material is more flexible!

So what happens when you add heat to the mix? Unlike air-dry clays, polymer clay requires heating in order to harden (cure). The reason for this can be explained by the properties of PVC and plasticizers. When you heat a PVC pipe enough, it becomes extremely flexible, which is how plumbers are able to more easily install pipes. After the pipe cools down, however, it becomes rigid again. The flexibility is due to the plasticizers, and the rigidity due to the PVC molecules. However, there's an important distinction to note: heating a PVC pipe does not get rid of the plasticizer molecules, but heating clay does. This is because polymer clay contains a specific plasticizer that is permanently removed by exposure to high temperatures.