How to make a polymer (plastic)

This document summarises the information found in the interactive image it accompanies.

Introduction

Polymers (also known as plastics) are very useful things. We use lots of polymers in everyday life; they are all around you!

The 'Polymer life cycle' sections below will explain more about polymers, and how they are made.

In the 'Meet the researchers' sections you can find out about scientists who work on polymers to uncover their many uses!

You can also make your own polymer model following instructions in the 'Polymer model' sections. You will need:

1. **String**
2. **Coloured beads (or something you can thread onto string, such as folded tin-foil or dried penne pasta)**

Polymer life cycle (1) - Monomers

Polymers are chains. Each chain is made from smaller parts called monomers.

Lots of different monomers can make polymers. Some are found in crude oil. Crude oil is made over millions of years from the remains of animals - we cannot replace it.

We can also get monomers from plants, such as lemons, and from waste gasses. We can always get more of these monomers, so they are better for the environment!

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Meet the researcher (1) - Natalia

Question: What do you work on?

Answer: I develop things that help to make polymers from monomers!

Question: What is your typical day like?

Answer: I start the day by reading about tests (experiments) that other scientists have done – this can inspire and inform my own work. To do my own experiment, first I prepare everything that I will need. I can then mix the ingredients so that they make a polymer. After lunch, I check what I made. I do different types of experiments each day!

Question: What is the most surprising thing you have discovered?

Answer: There are lots of surprising and interesting types of equipment. My chemistry has to be done in air which doesn't contain oxygen – this requires lots of special equipment to keep the air clean.

Question: Why did you become a scientist?

Answer: Since I was young, I was curious about science and I loved to learn about it. I like being a scientist because I can learn new things each day, and I can teach younger students – I hope they find it as fascinating as I did as a child!

Question: When you were in school, what was your favourite subject?

Answer: I liked physics, chemistry, biology and maths.

Question: How do you relax when you're not doing science?

Answer: I like to meet my friends and go to yoga classes.

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Polymer model (1) - Monomers

A polymer chain is made out of lots of small monomers. For your model, you will be using beads as your 'monomers'.

Choose some beads to make your polymer out of - they do not have to be the same as each other! There are lots of different shapes, colours and size of monomer, so try to find as many different beads for your model as you can!

If you have no beads, try penne pasta, or shape some coloured clay or tin foil

Polymer life cycle (2) - Catalysis

Polymers are made by a process called catalysis: this is how the monomers are joined together into a long chain.

Catalysts make a process happen (like joining monomers together), but they are not changed when they do it. This means we can use them again and again!

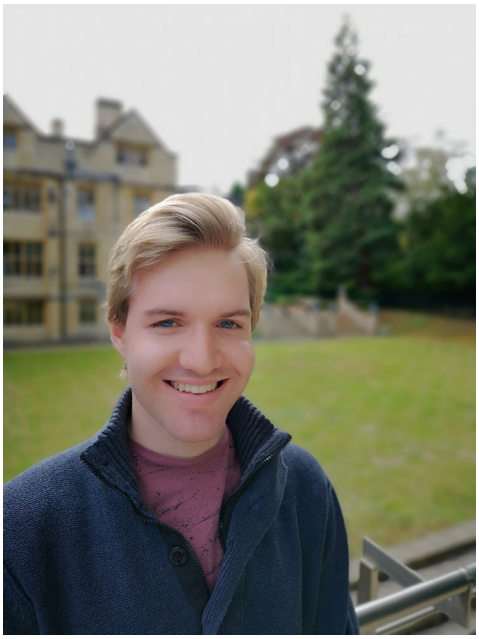
For example, a pair of scissors can cut paper in half. Afterwards, the scissors are the same, and we can use them to cut more paper. The scissors are like a catalyst.

Meet the researcher (2) - Wouter

Question: What do you work on?

Answer: I research how to make polymers. I make catalysts which force two metals together.

Question: What is your typical day like?



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Answer: On a typical day, I spend 4-6 hours in the lab setting up and taking down experiments. It is important that all the materials

I use are pure (made of only one material). I do a lot of work in a glovebox so I can keep my materials pure. I make catalysts and then test them out.

Question: What is the most surprising thing you have discovered?

Answer: I discovered that small changes can lead to surprisingly large effects, especially in chemistry and research.

Question: Why did you become a scientist?

Answer: I became a scientist because I have always loved the sciences and maths. I enjoy understanding how things work. Also, I wanted to find a way that I could help our environment which I am now able to do through my research.

Question: When you were in school, what was your favourite subject?

Answer: My favourite subjects at school have always been chemistry and maths.

Question: How do you relax when you're not doing science?

Answer: To relax, I like to hang out with friends, watch TV, go hiking and play video games.

Polymer model (2) - Catalysis

Now we have your monomer beads, we can make a polymer! To make your polymer by catalysis, thread your beads onto string to form a chain.

Your hand is working as the catalyst because it doesn't change while doing this process. After your hand adds a bead it can keep adding more beads!!

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Polymer life cycle (3) - Properties

Polymers can have lots of different properties; some are hard, like glasses lenses; some are stretchy, like cling film.

Polymers with different properties are used to make different things. For example, polymers that stretch to be very thin can make bin bags.

Activity: Can you find polymers with different properties in your home?

1. Hard (try glasses, or a cup)
2. Stretchy (try cling film, or bin bags)
3. Soft (try a cushion, or clothes)

Meet the researcher (3) - Holly

Question: What science research do you do?

Answer: I am a polymer chemist – this means that I look at ways to make new plastics, which are more environmentally friendly and have good properties. I am working on polymers to be used in batteries.

Question: What is your typical day like?

Answer: I work in a laboratory. I often make polymers, which involves stirring different chemicals together. Once the polymer is made, I can use different machines to test its properties – such as its strength, and its melting temperature.

Question: What is the most surprising thing you have discovered?

Answer: That doing chemistry is a slow process – it can take a while to get results!

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Question: Why did you become a scientist?

Answer: I was interested in science at school and wanted to use it to solve real-world problems.

Question: When you were in school, what was your favourite subject?

Answer: I liked chemistry, of course, and geography.

Question: How do you relax when you're not doing science?

Answer: I enjoy reading, spending timing outdoors, and practising taekwondo.

Polymer model (3) - Properties

Polymers have different properties because they are made of different monomers, arranged in different ways. Try making a new polymer model with your beads and string - what is different between this model and the first one you built?

In polymers, long chains are harder than short chains. A polymer chain doesn't have to be in a line - they can be branched like a tree with lots of chains crossing over each other!

Can you make a branched polymer chain?

Polymer life cycle (4) - What next?

We want to make materials which last a long time. However, an object made from polymer can not last forever; when it is no longer useful, what can we do with it?

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1. Throw away – It is easy to throw polymers away, but it is wasteful (e.g. crisp packets, food packets)

2. **Recycle - When a polymer is recycled, it is moulded into a new shape (e.g. milk bottles, many plastics)**

3. **Degrade - Degrading a polymer means the long chain is broken back down into the monomers it was made from.**

Meet the researcher (4) - Jamie

Question: What do you work on?

Answer: I am a supramolecular chemist – this means that I look at how molecules (tiny building blocks which make up our world) interact. I am aiming to make a catalyst for producing polymers which can be degraded.

Question: What is your typical day like?

Answer: Working in a lab, I see what happens to chemicals when they are mixed. I use a lot of different machines, which all tell me about different properties of the chemicals.

Question: What is the most surprising thing you have discovered?

Answer: Research can take you on quite the journey. Often you can start off one way, and find something completely unexpected!

Question: Why did you become a scientist?

Answer: I have always been interested in how the world around us works. Being a scientist lets me explore interesting questions while developing new things which can solve real world problems.

Question: When you were in school, what was your favourite subject?

Answer: Chemistry! Or if that's not allowed to count, probably history.

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Question: How do you relax when you're not doing science?

Answer: I enjoy volunteering, spending time walking and cooking.

Polymer model (4) - What next?

When you are finished with your polymer chain, you can choose what happens to it next!

Will you throw it away (what a waste of beads!), recycle it (change your chain into a new thing, like a keyring or a necklace?), or will you degrade it (take the beads off the string to use another day)?

Well done!

Thank you for joining us to learn about polymers (plastics)!

We hope you have enjoyed this activity!

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