

SUSTAINABLE PLASTIC COMPOSITES

**Chemical and Process Engineering and
Pure and Applied Chemistry**

University of Strathclyde

PLASTICS HAVE MANY USES



WORD CLOUD

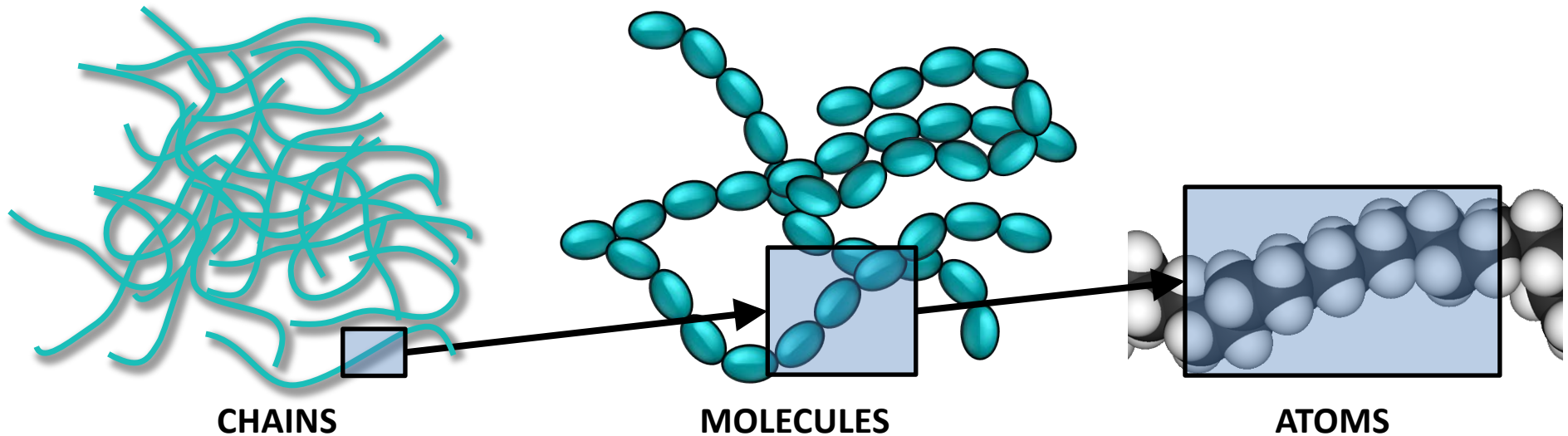
Can you name up to three objects in your home that contain plastics?

Scan the QR code or visit pollev.com/chemengstrat916



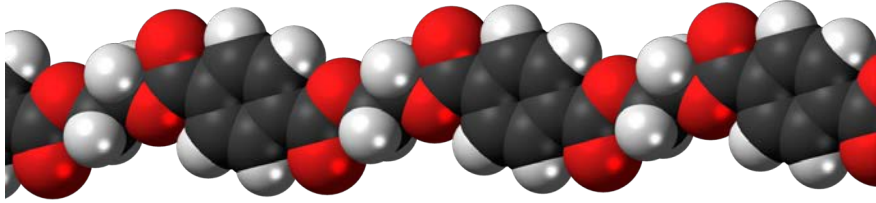
WHAT ARE POLYMERS?

Polymers are long chains of repeated molecules.

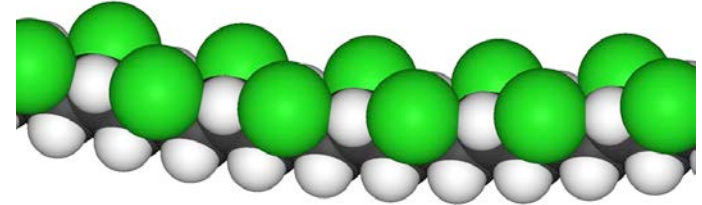


Polymers are often mixed with different materials to form **plastics** with improved strength, flexibility, etc.

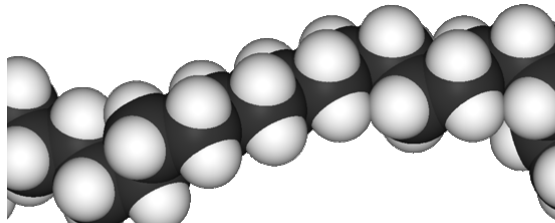
COMMON POLYMERS AND RECYCLING



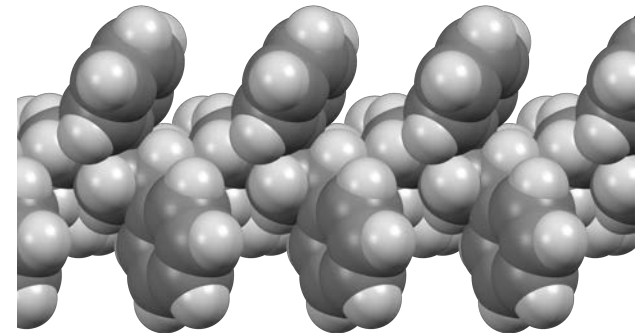
polyethylene
terephthalate
 $--[CO_2C_6H_4CO_2(CH_2)_2]_n--$



polyvinylchloride
 $--[CH_2CHCl]_n--$



polyethylene
high density
 $--[CH_2CH_2]_n--$



polystyrene
 $--[CH_2CHC_6H_5]_n--$

PLASTICS AND THE ENVIRONMENT



Most polymers are made from **fossil fuels**.
2.4 million tonnes of plastic packaging waste in 2017.
Packaging in the UK is nearly 70% of our plastic waste.

Plastic bottles are generally made with pure PET and are **easily recycled**.

Food waste is a major emitter of greenhouse gases.
Plastic film packaging **keeps food fresh** and extends shelf life. However, **plastic film cannot be recycled**.

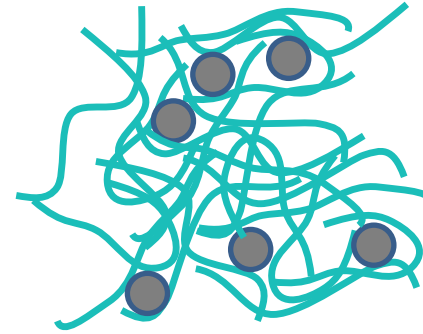
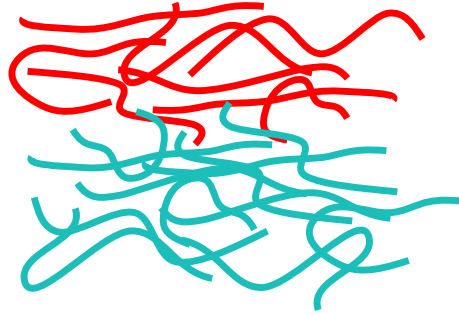
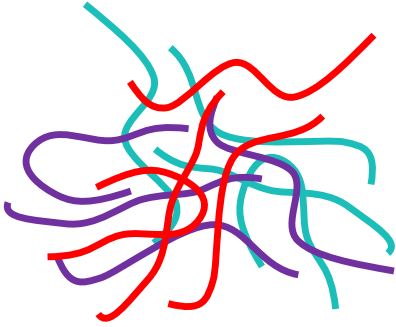
TAKE THE PLASTIS QUIZ

What do you know about plastics and sustainability?

Scan the QR code or visit <https://bit.ly/3sMPK1c>



WHY IS PLASTIC FILM DIFFICULT TO RECYCLE?



Plastic film can be a mixture of different polymers e.g. polymer blends or layers

Polymers with fillers such as chalk and clay



These plastics have better properties than pure polymers but are *not recyclable as it is hard to separate the polymers.*

Even if food packaging film is made from a pure polymer it would still *not be recyclable because of food contamination.*

SUSTAINABLE PLASTIC FOOD PACKAGING

Could we use compostable, sustainably-sourced plastic film for food packaging?

- Traditional polymers are sourced from fossil fuels. Sustainable polymers are **sourced from renewable biomass** e.g. alginates, cellulose, polyhydroxybutyrate.
- **Compostable plastic film** could be disposed with food waste or if sent to landfill would safely decompose in the environment.



Alginate and **cellulose** can be sourced from seaweed.

Cellulose is sourced from plant matter.

Polyhydroxyalkanoates can be made using bacterial fermentation of food waste.

Why are they not already used for food packaging?

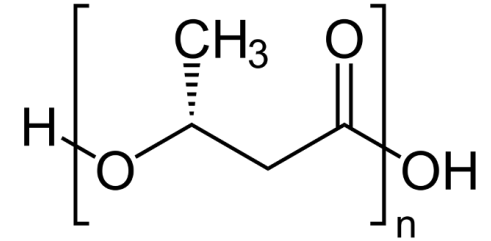
Food packaging must be strong, flexible and provide a barrier for gases and water.

BIOCOMPOSITES FOR FOOD PACKAGING

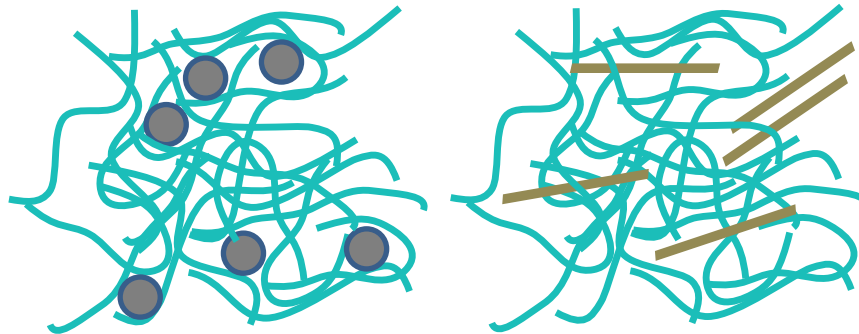
The team at the University of Strathclyde received UKRI funding to develop **compostable** plastic films for food packaging based on **polyhydroxyalkanoates (PHAs)**.

We aim to

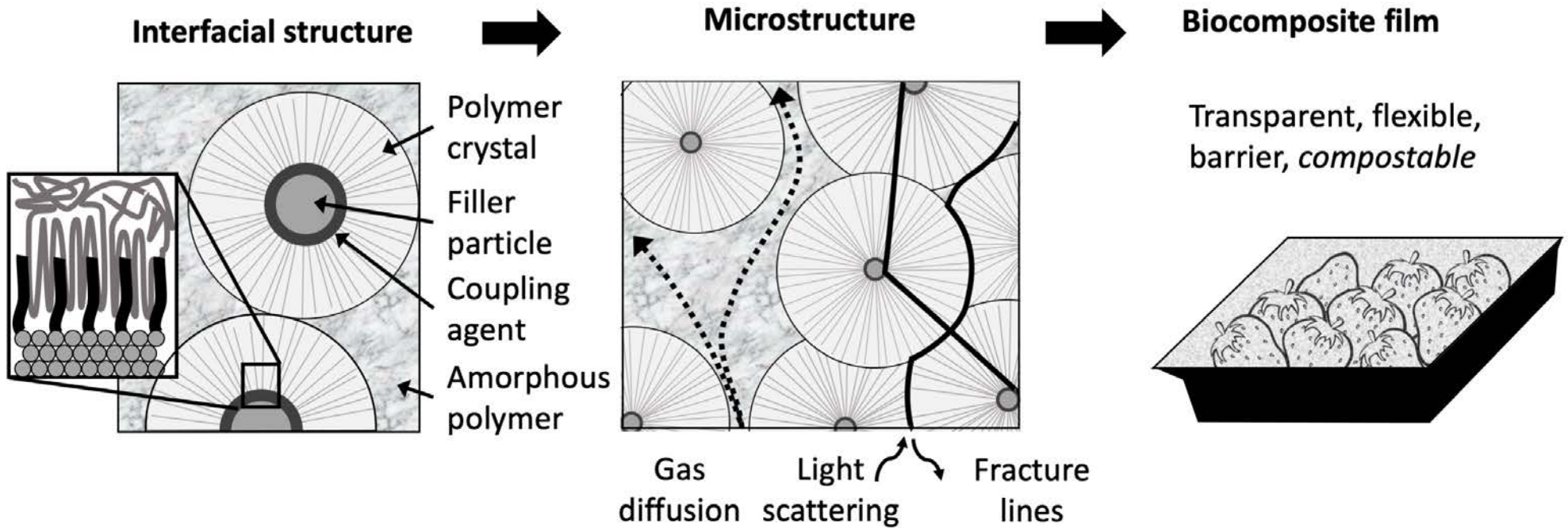
- 1) **optimise compostable** food packaging films and
- 2) **develop design principles** that could be used to optimise other compostable plastics, such as alginates or cellulose.



polyhydroxybutyrate
--[OCHCH₃CH₂CO]_n--



OPTIMISING COMPOSTABLE FOOD PACKAGING



Computer simulations

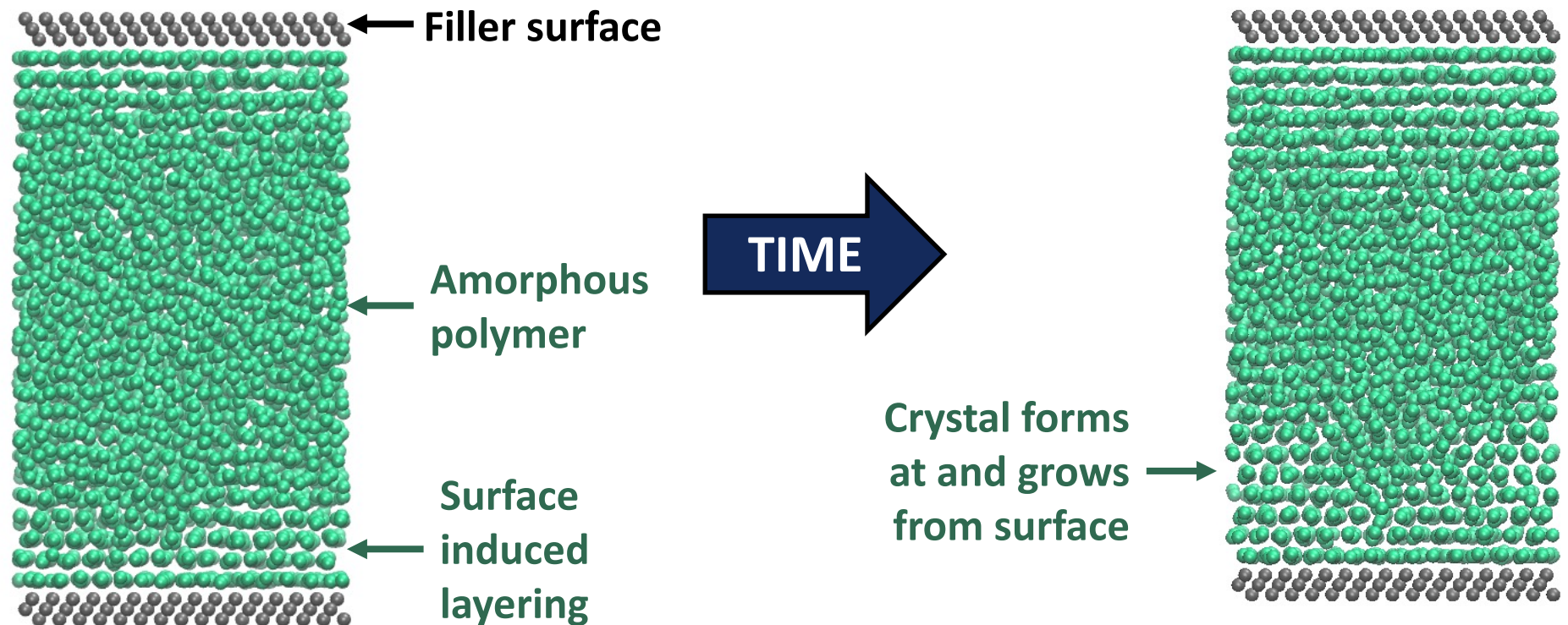


Experiment

Design rules to enable faster development of sustainable plastics

SIMULATIONS OF POLYMER CRYSTALLISATION

Crystals increase the gas and water barrier, but must be embedded in amorphous regions for flexibility. We will use simulations to understand how additives and filler particle surfaces influence polymer crystallisation.



Surfaces can be changed or modified to see how this affects crystallisation.

PROCESSING AND CHARACTERISATION

Experiments will test the effect of processing and additives on **crystallisation, microstructure** and film **performance**



1) **PHB powder** is mixed with **fillers** and/or **plasticisers**

2) The mixture is **processed** into a **thin plastic film**

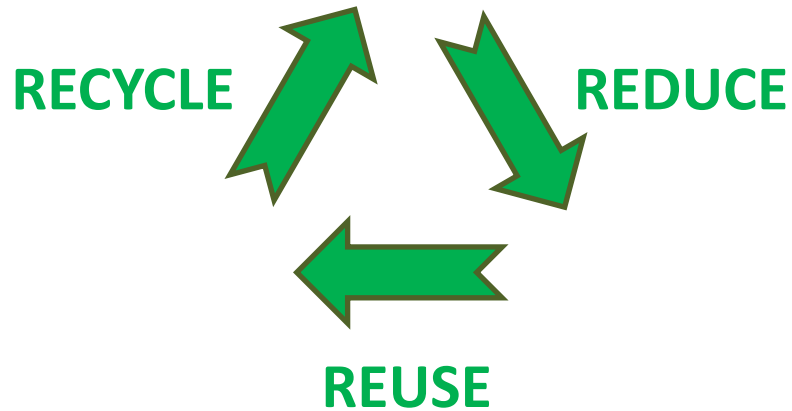
3) The **properties** of the thin plastic film are **characterised**



Repeat 1-3 with different components and processing conditions to **optimise the plastic film**.

PLASTIC SUSTAINABILITY

Remember the 3Rs:



For more ideas and info visit:
zerowastescotland.org.uk



Acknowledgements

UKRI Smart Sustainable Plastic Packaging (NE/V010603/1)

<https://www.ukri.org/news/8-million-for-sustainable-plastics-research-projects/>

Archie-WeSt supercomputer



What can you do?

Write down some things you can do at home, to **reduce** **reuse**, or **recycle** plastics.

