GENIE IN A BOTTLE?

Two scientific breakthroughs could hold the key to combatting the word's plastic pollution crisis.

The plastic bottles we drink from today will outlast us by hundreds of years. So too will the plastic trays our supermarket chicken is packaged in, the garish toys cluttering up our playrooms, and all manner of other things now made from PET (polyethylene terephthalate), a material hailed as groundbreaking at the time of its invention which is now posing one of the most significant environmental threats our world has faced.

Around a million plastic bottles are sold every minute around the globe, but only 14 per cent of those are recycled. Many others end up in landfill or, worse, in our oceans and seas, which are now so universally polluted with plastic that the material is harming marine life and entering our food chain through the fish that we eat.

With public concern over single-use plastics mounting, some of the world's biggest food, drink and cleaning product manufacturers recently signed up to an ambitious, UK-led initiative to significantly reduce their role in plastic pollution. Forty-two businesses, including Coca Cola, Pepsi Co, Proctor and Gamble, Unilever, Birdseye and Nestle have promised to reduce packaging and increase recycling as part of the UK Plastics Pact, and make 100 per cent of their packaging recyclable by 2025. Elsewhere, dozens of countries, from China to Kenya to Germany, have banned plastic bags altogether, or introduced charges for them to encourage shoppers to carry reusable bags. The UK has also unveiled ›

Right: Dozens of countries have banned plastic bags altogether

Below right: Around a million plastic bottles are sold every minute around the globe, but only 14 per cent of those are recycled

plans to ban wet wipes, which are blamed for clogging up the country's sewers before making their way into the ocean.

Finding new ways to package our products, and to recycle the plastic already in our environment, has become a top priority for many governments across the globe. Now there is hope on the horizon with two recent significant scientific breakthroughs that suggest we could be closer to finding a solution to our mounting plastic problem.

The first of these came when an international team of scientists revealed they had accidentally created a mutant enzyme that can break down plastic drinks bottles. It followed the discovery in 2016 of a bacterium that had naturally evolved to eat the plastic left at a waste dump in Japan. Intrigued, the team tweaked the enzyme in a bid to work out how it had evolved in such a way – but they inadvertently made the molecule even more effective at breaking down PET.

Their research, published in the journal *Proceedings of the National Academy of Sciences*, is now being hailed as a potential first step towards changing the way in which plastics can be recycled.

"What actually turned out was we improved the enzyme, which was a bit of a shock," said Professor John McGeehan, who led the research at the UK's University of Portsmouth. "It's incredible because it tells us that the enzyme is not yet optimised. It gives us scope to use all the technology used in other enzyme development for years and years and make a super-fast enzyme."

While the molecule currently takes a few days to begin breaking down the plastic, which would take hundreds of years to degrade otherwise, the group is hopeful it can improve the enzyme further to make it far faster acting, paving the way to complete plastic recycling in future.

Furthermore, while bottles that are recycled can currently only be turned into opaque fibres for clothing or carpets rather than be returned to their original constituent parts, the new enzyme could potentially make it possible to recycle clear plastic bottles back into clear plastic bottles, slashing the need to produce new plastic.

"It's well within the possibility that, in the coming years, we will see an industrially viable process to turn PET, and potentially other [plastics], back into their original building blocks so that they can be sustainably recycled," said McGeehan. "You are always

HOW LONG TILL THEY'RE GONE?

Estimated time taken to biodegrade

Exact time will vary by product type and environmental conditions. Source NOAA/Woods Hole Sea Grant

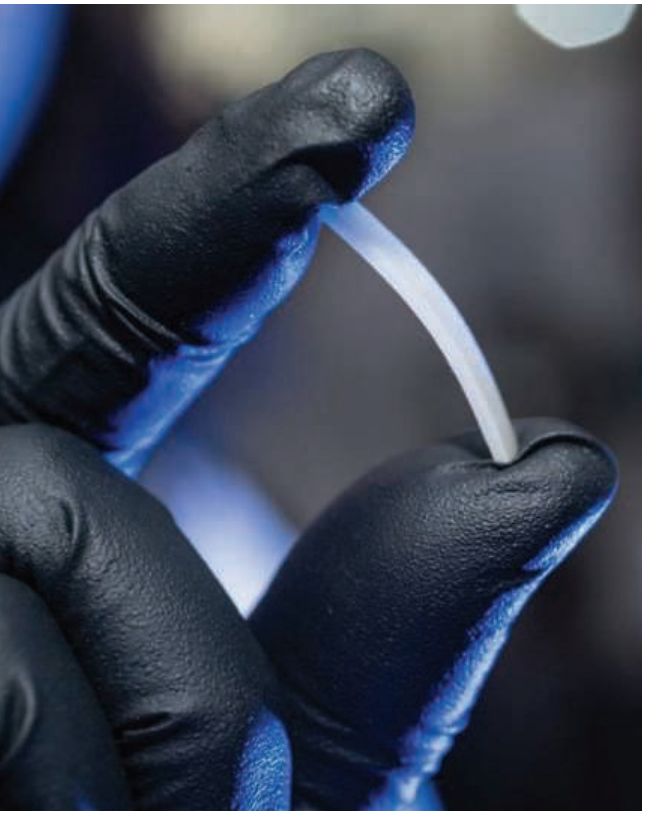
Stryroform cup
50 years

Aluminium can
200 years

Nappy
450 years

Plastic bottles
450 years

Fishing line
450 years



up against the fact that oil is cheap, so virgin PET is cheap. It is so easy for manufacturers to generate more of that stuff, rather than even try to recycle. But I believe there is a public driver here. Perception is changing so much that companies are starting to look at how they can properly recycle these."

Meanwhile, at the same time as McGeehan's team was working on its bacterium, a team of scientists at the USA's Colorado State University was busy making a breakthrough of its own, inventing a new type of plastic that they believe could prove infinitely recyclable.

The material, created by Professor Eugene Chen and unveiled in the journal *Science*, has many of the same characteristics of everyday plastics such as PET, including strength, durability and heat resistance, but unlike those plastics, can be broken back down into its constituent molecules. This would make it far easier to recycle than conventional plastics, which require toxic chemicals or complicated procedures for the diminishing return of opaque fibres with limited further use.

The team's new material is relatively environmentally-friendly to manufacture, too, and can be created at room temperature, with only tiny amounts of a catalyst and without the use of solvents.

Theoretically, say the team, this process of chemical recycling could see a plastic bottle recycled to make new items multiple times. "The polymers can be chemically recycled and reused, in principle, infinitely," said Professor Chen.

In an article commenting on the new discovery, renowned chemists Dr Haritz Sardon and Professor Andrew Dove discussed the new material's relevance for the future of recycling, writing that such discoveries could "lead to a world in which plastics at the end of their life are not considered as waste but as raw materials to generate high value products and virgin plastics. This will both incentivise recycling and encourage sustainability."

Chen stressed that the new polymer technology has only been demonstrated on an academic lab scale, and that a great deal of further work will be needed to perfect it for use on an industrial scale. However, with the help of a seed grant from CSU Ventures, the chemists are already working on improving and upscaling their process. "It would be our dream to see this chemically recyclable polymer technology materialise in the marketplace," said Chan. With such significant commitments now in place from global firms seeking to reduce their plastics waste, Chan won't be the only one hoping his team succeeds.

Above left: Eugene Chen's lab at Colorado State University has developed a completely recyclable polymer

Above: Inspecting recycled plastic