**If you could somehow wave a magic wand and instantly remove every plastic-based product from the world, most people, at least in the industrialised nations, would probably be dead within about a month or so.**

**Plastics have become essential components in just about every aspect of modern life and they’ll continue to be essential for the foreseeable future. Now you could argue that the ubiquity of plastics is purely a product of brilliantly aggressive marketing by the industry’s PR people. But let’s face it, they were pushing at an open door, weren’t they? Plastic bottles are lighter and safer than glass and therefore cheaper and less environmentally impactful to transport. Plastic bags are light and durable and easy to store. Household plumbing and electrical systems are infinitely safer and more reliable as a direct result of plastic materials. The manufacture of computers, tablets and smartphones, which have enabled the information technology age we know live in, would probably never have happened without the various types of plastic that make up the majority of their structural elements. Plastic have also led to huge advances in medical research and equipment, saving countless lives over the last few decades. And they’ve enabled the transport industry to reduce weight in road vehicles and aviation so that each journey consumes far less fuel and therefore emits far fewer greenhouse gas emissions. I could go on, but you get the idea.**

**In fact, plastics are almost too good! Which, as we’ve all now come to realise, is why we’ve got such a massive problem with plastic waste, not only in our landfills, but increasingly in our waterways and oceans. The infamous Pacific garbage patch is now the size of France and contains about eighty thousand tonnes of waste plastic, mostly in the form of discarded fishing gear. That waste is gradually breaking down into microplastics that get into the food chain 2:07 and eventually into human beings, as this Queensland study is currently attempting to quantify and clarify.**

**According to Plastics Europe, in twenty-twenty the world produced three hundred and sixty-seven million tonnes of brand-new virgin plastic, and it’s reckoned that since it first burst into our lives in the nineteen fifties, just over eight billion tonnes have been churned out, about half of which is still kicking around in one form or another. That’s a greater weight of plastic than all living biomass on the planet. And plastic manufacturing releases greenhouse gases that contribute to global warming. A twenty-twenty-one report published by the Beyond Plastics team at Bennington College in Vermont found that the US plastics industry alone produces two hundred and thirty-two million tonnes of carbon dioxide equivalent emissions. That’s about the same as a hundred and sixteen coal-fired power plants.**

**Most recycling methods are expensive and frankly inadequate, generally degrading the material more and more on each cycle so that eventually it ends up as something unrecyclable, like a cheap carpet, after which it’s inevitably destined for the dreaded landfill, which means more harmful waste at one end while ever more brand-new plastics are being churned out at the other.**

**But now a new process has been developed that can rapidly deconstruct one of the most prevalent types of plastic at room temperature, keeping energy requirements and costs to a minimum. The resulting constituent materials can then be upcycled into value added products rather than downcycled into lower grade items. And the process can be repeated indefinitely without any degradation. So, have we finally found a way to keep plastics revolving around a circular economy and out of the waste stream?**

**Hello and welcome to Just Have a Think.**

**There’s no doubt that plastics have brought unparalleled prosperity in virtually every facet of society from healthcare and transport to agriculture and communications. But, on top of all the issues I mentioned a moment ago, it’s worth remembering that ninety nine percent of current production comes from an unsustainable and rapidly depleting fossil reserve. And we’ve only recently started to realise how our short-sighted product design approaches have inadvertently caused such a wide scale environmental problem. Now, of course there’s lots of work going on to develop more sustainable alternatives that are biodegradable or compostable. I’ve looked at products like PLA and PEF in a previous video, and they do look like they could reduce the leakage of harmful chemicals into our soils and water systems. I also looked at nature’s solution to the plastic bombardment, which is to evolve bacteria that can break down the polymer chains and use the carbon content as their fuel source. We’ll come back to that one in a moment.**

**But while these developments are an important step forward, they don’t address the linear nature of material production and disposal, particularly in single use plastic and packaging. In other words, we’ll still be churning out millions of tonnes of the stuff and relying on the fact that we can more easily dispose of it at the end of its life.**

**What we really need are processes that allow us to keep the product in circulation almost indefinitely. That’ll cut down on the energy and resources we need to produce new material from scratch and it’ll reduce the pressure on the world’s waste disposal system, which is another very energy hungry industry.**

**Unlike most existing mechanical recycling methods, which lead to all those cheap landfill carpets I mentioned earlier, chemical recycling can theoretically preserve the quality and integrity of a plastic over an infinite number of cycles. And the number of different monomers and derived chemicals that can be gleaned from the polymer structure of a plastic means lots of lucrative revenue streams for industry, which you’d think would make chemical recycling an attractive option for market driven corporations wouldn’t you? The trouble is though, the capital expenditure to set these systems up and the ongoing cost of operating them has proven to be a bit of a deal breaker for many companies, who remain slaves to ever increasing quarterly revenues and profits for their rapacious shareholders.**

**So, anyone who can come up with a way of chemically liberating the constituent elements of existing plastics in a less expensive, less energy hungry and more sustainable way, is probably onto a winner.**

**And this new research from The Centre for Sustainable and Circular Technologies at the University of Bath, here in the UK, looks like it might just fit the bill.**

**The process uses a zinc-based catalyst and methanol, to completely break down beads of a commercial polycarbonate known as ‘Polybisphenol A Carbonate’ , or BPA-PC. And it does it within twenty minutes, and crucially it achieves the transformation at**[**room temperature**](https://phys.org/tags/room+temperature/)**.**

**Several different formations of zinc were created using ligands, which are molecules or ions that can bind to a central metal atom to form what’s known as a coordination complex.**

**The much, MUCH more specific scientific explanation of the entire process is contained in this paper, published in February twenty-twenty-two in the ChemSusChem journal at the Chemistry Europe website. The intricate details are well outside the scope of this video but for those of you intrepid enough to wade through the typically impenetrable scientific vocabulary, I’ll leave a link to the paper in the description section below.**

**The result of all that jolly clever sciency stuff is that the Polybisphenol A Carbonate is converted into its chemical constituents, bisphenol A, and dimethyl carbonate. Essentially, they’re the building blocks of the polymer, which means there’s no material degradation during the process and it can be performed an unlimited number of times.**

**Bisphenol A is known to be a potentially damaging environmental pollutant, so using this to create new products and keeping it out of our landfills and water courses will be greatly beneficial to the earth’s ecosystems. Dimethyl carbonate is also a useful product that can be kept in the circular chain. It’s a valuable green solvent and a building block for other industrial chemicals.**

**Not content with breaking down this polycarbonate though, the team tried their new concoction on other polymers like polyethylene terephthalate or PET, which is what drinks bottles are made of, and polylactic acid or PLA, which is a renewable plastic made from things like sugar cane, starch and corn. And they found that, with the addition of a bit of heat, the zinc catalyst did a good job of breaking down these polymers as well.**

**The monomers derived from the PET breakdown were reconstructed to produce renewable polyester amides or PEAs which have excellent thermal properties, making them great candidates for biomedical applications like drug delivery and tissue engineering. Those are just a couple of examples of what the team has already achieved, but there are likely to be many more materials and applications that can be derived from this process as it gets ramped up to commercial industrial scale.**

**In this article by Vicky Just from Bath University, the paper’s Lead Author Jack Payne explains**

**"Whilst plastics will play a key role in achieving a low-carbon future, current practices are unsustainable.”**

**"Moving forward” he says, “it's imperative we source plastics from renewable feedstocks, embed biodegradability and recyclability at the design phase and diversify existing**[**waste**](https://phys.org/tags/waste/)**management strategies. Such future innovation should not be limited to emerging materials but [should] encompass established products too.”**

**They’re not the only ones trying to crack the plastic upcycling challenge though. You may remember back in March twenty-twenty I made a video looking at the amazing way bacteria in landfills have evolved so that they can break down the complex polymer chains of modern plastics and use the carbon content as their fuel source. It’s a very fortunate bit of support that nature has kindly provided for us rather profligate humans, and laboratory researchers have been trying to enhance and turbo charge the process into something that can be applied on a scale large enough to make a positive difference to our plastic pollution problem.**

**At the forefront of that research is a multinational consortium called MIX-UP, which is an abbreviation of the rather cumbersome title, Mixed Plastics Biodegradation and Upcycling using Microbial Communities. I don’t know about you, but I particularly like the idea of a community of microbes.**

**Anyway, they’re all about creating a truly circular economy for all types of plastic. Their objective is very clearly stated as**

**“Plastic waste to plastic value – by a sustainable, biotechnological conversion of unsorted, mixed plastics into valuable bioplastic using heavily engineered enzyme mixtures and mixed microbial communities.”**

**The project has fourteen international partners from Europe and China, all working towards commercially viable production of upcycled bioplastics by the end of this decade.**

**Whether it’s a newly created catalyst like the zinc ligand coordination complex at Bath University, or the amazing engineered super bugs currently being reprogrammed to chomp through all types of polymer structures, the key to mitigating environmental catastrophes from waste plastic pollution AND dramatically reducing greenhouse gas emissions from the production of virgin plastics is to ensure existing plastics are genuinely upcycled into value added products using processes that can be repeated more or less indefinitely.**

**It’s still relatively early days, and there will no doubt be lots of pitfalls and barriers along the way to full commercialisation of these upcycling processes, but we do at least appear now to have an industry that understands the size of the environmental emergency and which is rapidly developing several potentially effective solutions to the problem.**

**Now, if you’re working in this field and you’ve got some insights to share, or if you just have a view on how we should be dealing with plastics in general, then why not dive down to the comments section below, and leave your thoughts there.**

**That’s it for this week, though.**

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**As always, thanks very much for watching, have a great week, and remember to Just Have a Think.  
See you next week**