**Finally a plastic that nature can easily deal with**

**I’m sure you don’t need me to tell you that products made out of this stuff have become the cornerstone of our modern technological civilization. You can have any kind of plastic nowadays can’t you? It can be hard or soft, tough or flexible, air tight or air breathable, heat resistant or heat sensitive, rigid or foldable, translucent or opaque, I mean you name it you can have it!**

**The vast majority of them are extremely durable, impervious to corrosion and, to all intents and purposes, pretty much indestructible in nature, which is why the flip side of this modern technological marvel has become such a scourge in our urban, rural and ocean environments.**

**We’ve checked out several potential solutions to the plastic pollution challenge here on the channel over the years. Everything from plastic alternatives made from corn or sugar starch, to naturally occurring enzymes that can chomp through certain types of polymer, like the brilliantly named Ideonella Sakaiensis that we looked at a couple of years ago.**

**One of the challenges that the plastic makers of the world have accidentally set for themselves is the very fact that the bonds of the polymer chains that create plastics are extremely strong. If you weakened them to enable plastics to break down more easily, then all you’d do is create a useless plastic that nobody wanted wouldn’t you?**

**Or would you?**

**WELL! there’s a team of jolly clever scientists 1:25 in a place called Konstanz, down here on the border Germany and Switzerland, who reckon they created a polymer material that squares that circle and solves the conundrum of a practically useful plastic material that is genuinely compostable once it’s thrown away. 1:41**

**So, we’ve gotta check that out, haven’t we?**

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

**Now, I’m not a scientist, as you know, so although I THINK I’ve made a stick model of a ?? polymer chain here, I fully expect there to be some forthright feedback in the comments section from well meaning materials scientists pointing out the I’ve incorrectly connected the balls on the model and therefore instead of creating polyethylene 1743 dash A, I have in fact created polypropylene 9384 dash C!**

**Anyway the point is that these stick like bonds in a polymer chain are really very sticky indeed, at least in the sense that they are extremely happy where they are and are incredibly reluctant to be broken down.**

**This new research paper from our friends at the University of Konstanz, led by chemical material scientist, Stefan Mecking, presents us with a brand-new plastic construction that appears to have all the properties of a hard-wearing industrial material, while being environmentally disposable too. All sounds a bit too good to be true, doesn’t it? So, what wizardry have they come up with then?**

**Well, to give you an idea of how I frazzle my brain researching these videos every week, let me just read you the intro paragraph from the paper.**

**“We report a novel polyester material generated from readily available biobased 1,18-octadecane dicarboxylic acid and ethylene glycol similar to high density polyethylene which despite its crystallinity, high melting point and hydrophobic nature, is subject to rapid and complete hydrolytic degradation in in vitro assays with isolated naturally occurring enzymes and is biodegraded with mineralization above 95% within two months as a result of the strong impact of the nature of the diol repeating unit, possibly related to the density of ester groups in the amorphous phase. Depolymerization by methanolysis indicates suitability for closed-loop recycling.”**

**Now, if you’re a chemical materials scientist you can probably switch off at this point because I have apparently just provided you with all the information you need. For the rest of us though, let’s just have another quick look, shall we?**

**That high density polyethylene the paper mentioned is perhaps one of the most common examples of a polymer in which the long linear chains of hydrocarbons derived from oil, pack themselves into a tight crystalline structure held together by a phenomenon known as van der Waals interactions**

**That creates an overall material that is highly water resistant and which just DOES NOT want to come apart at all, which makes it a nightmare to get rid of when you’ve finished with it because naturally occurring enzymes that might be able to dismantle the stuff find it almost impossible to wheedle their way inside the structure to chomp on the polymer links.**

**Plastics that claim to be biodegradable, tend to be chemically manipulated to have very low crystalline structures. That makes the polymer chains more accessible, but it also removes many of the useful structural properties of the material, which means these things are typically only useful for flimsy stuff like cling film.**

**The Konstanz team had already shown that it was technically feasible to produce a type of polyester with what they call ‘a low density of in-chain functional groups’ that could be used as breaking points in a polyethylene chain. The big advantage of this construction was that those ‘in chain polyester groups’ didn’t change the crystalline structure of the material, which meant the team were able to retain all the useful properties of polyethylene, but with a material that could be chemically recycled at relatively low temperatures of between a hundred and twenty and a hundred and eighty degrees Celsius.**

**But nature doesn’t have a fleet of Bunsen burners and glass containers to cook all this stuff up does it? It relies on those enzymes I mentioned earlier, usually in the presence of water, to degrade materials over time. And that was proving to be a bit of a wrinkle. An early version of the material, called polyester -18,18 was found to be sufficiently water proof and crystalline that it displayed and an ability to survive intact in a aqueous acid solution for more than a year.**

**In other words…no good really.**

**This new breakthrough material, that the Konstanz team have snappily called ‘polyester-2,18’ was created by taking** **an existing material called a dimethyl ester and applying a very sciency sounding process called ‘dibutyltin oxide catalysed polycondensation’ to it to produce different diols. So how do we unpack that lot then? Well, I’m not going to explain dibutyltin oxide catalysed polycondensation here in this video, largely because I don’t have the slightest notion what it is. Suffice to say, it apparently alters the make-up of the material in meaningful ways that people much smarter than me can measure and quantify. I CAN give you a bit of info on diols though. They’re a type of chemical compound containing two hydroxyl groups, and the most common form of industrial diol is good old ethylene glycol, which is the stuff that makes anti-freeze work.**

**The result of all this chemical jiggery-pokery was a material with a crystalline structure very much like commercially available high density polyethylene, or HDPE and with similar tensile properties to HDPE, but which could also be readily broken back down into ethylene glycol by natural enzymes in a water based solution at a temperature of only thirty seven degrees Celsius within just a few days, OR alternatively, almost completely biodegraded, or mineralised in a couple of months at fifty-eight degrees Celsius under industrial composting conditions that met the stringent standards of a European norm called ISO 14855.**

**As a bonus you get you ethylene glycol back out of the process, which is a product that you can sell back to industry for all sorts of applications, which means all of a sudden there’s a commercial motivation for recycling a plastic, which is not something that can be said for most existing plastic recycling processes in use around the world today.**

**Now before we get too giddy with excitement, we probably need to heed to wise words of Stefan Mecking himself in a recent interview with the online journal SciTech Daily. He said this :**

 **“Of course, we cannot transfer the results of the composting plant one-to-one into any conceivable environmental condition. But they do confirm that this material is indeed biodegradable and indicate that it is much less persistent than plastics like HDPE, if it should unintentionally be released into the environment.”**

**So, when I used the phrase ‘breakthrough material’ earlier on I perhaps should have used a phrase like ‘gently nudging material’ instead. But it IS arguably a step in the right direction. Or perhaps you might be thinking that instead of encouraging our dear friends in the fossil fuel and petrochemical industries to continue churning out billions of tonnes of products made from oil, we should instead be enthusiastically embracing alternatives like the bioplastics I mentioned right at the start of the video. And that is indeed a small but rapidly growing sector. Here’s a very trendy looking example from a US start up called COVE, made from PHA, which is basically fermented sugar or corn oil. If you live in California, then you’ll soon be able to buy one of these bottles from an organic grocery store called Erewhon.**

**But then again, if we converted all the world’s plastics to corn or sugar-based materials, then our friends in the commercial world would probably start ripping up huge tracts of land and destroying crucial ecosystems and biodiversity to create massive mono-culture plantations for the feedstock, much like they already do in places like Brazil to grow sugar cane for the bioethanol that runs the vast majority of the road vehicles in that country.**

**You could also argue that we should simply do away with plastics al together and go back to a simpler lifestyle like in the good old days…before computers and TVs and telephones and life-saving medical implants and penicillin and electricity [tails off..jump cut back to main view]**

**It’s quite a moral maze isn’t it, and I can’t afford Michael Buerk’s fee unfortunately. That’s a British Radio 4 reference that’ll probably mean absolutely nothing to anyone watching outside the UK, so you know…Google it I guess?**

**Anyway, the point is that there are almost as many opinions on this topic as there are people watching this video, and given that you are one of those people, it’s entirely possible that you may have one of those opinions. And if you do, then as always, the place to express is in the comments section just below this video.**

**That’s it for this week though. A huge thank you, as always to the fantastic team of channel supporters over at Patreon who literally keep this channel running and help me to keep these videos free of ads and sponsorship messages. And I must just give a quick shout out to some folks who’ve joined recently with pledges of ten dollars or more month. They are**

**Ben Samways**

**Nancy LaPlaca**

**Eric t’Sas**

**Markus Klein**

**Noam Gressel**

**Patrick Ophuls**

**Valentino Vago**

**Norm Zemke**

**Brian Peck**

**Keegan Knight**

**Bill Russell**

**Mark Chen**

**Tom Gearing**

**And of course a huge thank you to everyone else whose joined too.**

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**And of course, if you found this video useful and informative, then make sure you click the ‘subscribe all’ option in YouTube’s drop down menu, so you can be sure to be notified whenever a new video comes out.**

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

**See you next week**