David Glanz: Imagine being able to completely recycle plastic. No more islands of rubbish in mid-ocean, no more bottles and straws on the beach. In a world awash with plastic waste, Professor Thomas Maschmeyer's start up company, Licella, could be a game changer. Thomas is professor of chemistry at the University of Sydney, and he's the winner of the prestigious 2018 CSIRO Eureka Prize for Leadership in Innovation and Science. And of course, he's a fellow of the Australian Academy of Technology and Engineering, which is bringing you this podcast.

David Glanz: I'm David Glanz and I'm here with Thomas at the University of Sydney.

David Glanz: So, Thomas, tell us how Licella is going to help deal with plastic pollution. What's your secret?

Prof Maschmeyer: Right, so our secret source is that we're using super critical water, and a range of catalysts. And that allows us to control the radical chemistry in the reactor. And we're able to treat, therefore, any kind of plastic that comes our way, and we limit the crosstalk between the different types of plastics as we cut the plastic down, as we demineralize it.

David Glanz: So let's take us through that one step at a time for non-experts, like myself. Which reactor are we talking about?

Prof Maschmeyer: Right. So it's what we call the CAT-HTR reactor, the Catalytic Hydrothermal Reactor, and it's basically a hot tube that is taking our super critical water, so that is water that is effectively a gas, so steam. But highly compressed. So that it can actually dissolve things like a liquid. It's a forth state of matter. We don't usually encounter it because when we do we will die. Very high pressure, very high temperature. And so we're talking about above 400 degrees and above 200 bars. And under those conditions, plastics degrade very rapidly, and one of the issues with technologies in this field is with all this mixed plastics, they react together and form horrible things. You get [inaudible 00:02:17] looking things, very unstable oils, et cetera, and in our case, that's not the best.

David Glanz: Okay, so, this is obviously a breakthrough. In what way is the technology different from what's come before?

Prof Maschmeyer: So, the main competitor technology is full gassification, like they used to do with coal to make town gas, you know, 100 or more years ago. And pyrolysis, which is to take a plastic and just heat it to a very high temperature, but not enough to make a gas, but just enough to make a liquid. But those liquids are very unstable and they cross connect, again, to make new kinds of plastics which are not soluble, not tractable, et cetera. So, often the yield is quite low. It might be 50 percent, 40 percent, 60 percent of the initial plastic that is in oil and the rest is this intractable, solid tar like material.

Prof Maschmeyer: In our case, we use water as our processing medium. And that water allows us to transfer heat in a very special way because we are super critical, so the heat transfer is almost instantaneous. And the water also is a reactant, it keeps the radicals that we are forming less radical, as you will. Moderates the activity so they don't react with each other. And when we adapt as an output of our first few tests, that was a real eureka moment. That we saw that when we mixed polyethylene and polypropylene and polystyrene, we didn't have crosstalk. We just had the fragments of those polymers existing and breaking down on their own.

David Glanz: And this, I presume, can scale up to quite large operations, then?

Prof Maschmeyer: Yes, absolutely. So, we currently have a demonstration plant in the north of Sydney at Somersby at about 10,000 tons a year and we're building our first modular units in the UK at 20,000 tons a year. We hope they will be commissioned by the end of 2019, and produce the first commercial product early 2020.

David Glanz: And because this is obviously much more efficient and produces fewer dangerous by products, I'm assuming it's economically more viable?

Prof Maschmeyer: Yes. It's economically, highly viable. We don't make dioxins as side products, which means it's a lot cheaper to treat our waste, our affluent, our gasses that are generated, so we are very, very competitive, especially as oil prices of 80 dollars a barrel, we're ultra competitive. But we believe that, from our modeling, with various assumptions of course, that our plants will be paid off in under 2 years.

David Glanz: Oh, that's amazing. So I assume that the world is beating a path to your door?

Prof Maschmeyer: Yes. You could say that. Especially with changes in legislation in Europe in terms of having life cycle ownership in the sense of plastics, to be able to sell from 2000, I think, 35 onwards. As well as some states in the US are being much tougher on plastic manufacturers, we have the usual suspects, to quote the Humphrey Bogart movie, we have the usual suspects knocking at our door. And we are quite inundated with approaches and excitement.

David Glanz: Well, for many people, that would be just enough excitement by itself, but I understand you have another very exciting start up, Gelion, which is looking at improving batteries to allow for scalable green power. That sounds amazing, tell us more about it.

Prof Maschmeyer: Okay. So basically, the super critical stuff works and the mind is fertile in the academic environment, so I felt I needed to do something else. And so we thought about batteries, because in terms of introduction of renewable energy into the grid, storage is the key. And a number of different storage approaches of course, there's hydro storage in dams for very, very large scale, and then the

storage in batteries. And one of the key problems with batteries was the lifetime, the cost, the safety ... And so I felt, well, we need to address that in some way. And Gelion is a battery that is long lived, very cheap to produce, and very, very safe. It's designed in such a way that it cannot catch fire from the inside out. So the battery will never be the source of an ignition of a fire. Clearly, if I'm in a firestorm or I put a flamethrower to it in my plastic casings, they will of course catch fire. But it's never going to be the battery. In fact, the battery will be the slowest and last thing to burn, because of the chemistry that we're using.

David Glanz: And again, is this prototype stage, or production?

Prof Maschmeyer: We've now got a company with 20 full time employees and a few consultants, et cetera, around it. And we are about to make our first commercial demonstration product, which is a light pole with one of our battery types. We have two battery types and that is going to go public February of next year as a first demonstration and that is a solar light pole with solar panels on the one side and flat light on the other, and the battery's at the base of the tower that is hurricane rated. And we are currently in negotiations with a number of companies who would like to buy these light towers, and we are at the process of finding paths towards manufacturing enough batteries. What we find is the market is there, people are very excited, they say, where can I buy these batteries, it's fantastic what they can do. And so now it's up to us to find a path towards manufacture. Which is a hurdle.

David Glanz: The companies you founded are active on four continents and are worth millions of dollars, and just for those who are listening, I mean no disrespect, you're actually in a very, should we say, conventional professor's office at a group of eight university, I mean this isn't a flash, corporate set up with an atrium and flunkies. How do you combine being a researcher and an entrepreneur and which bit gives you more pleasure?

Prof Maschmeyer: Oh, I think both sides give me sort of even pleasure in equal amounts. The combination of things, well, basically the research group does the fundamental work, and our fundamental work is aimed at understanding why certain solutions aren't there. Why aren't there certain technologies out there? And then I tried to go and dive deeply and find a chemical reason for why that is a problem. And so we work out the fundamental reasons for why there has been a challenge, and do the fundamental science. If we are successful, we A, have a great piece of fundamental science to get us front pages on various journals, as well as a chance to then apply it. And once in a while a breakthrough comes through that is big enough to warrant to try and take it to market. And so that's really the path of our work. It's very much fundamental, very much driven by intellectual excellence, but then with an eye towards application. To also inspire the students and give them a path towards leaving the university and becoming part of a commercial company, and that has happened quite a lot in my group.

David Glanz: Industry and academic research sometimes lock heads, industry thinks the academics are too otherworldly, academics think industry is driven too much by media to turn around, you've obviously got a success story, or two success stories here, now about bringing the two together. What would your advice be either to a business person listening to this or to an up and coming, early career researcher?

Prof Maschmeyer: Right.

Prof Maschmeyer: So, my philosophy has always been to absolutely know one's strengths, and that means I absolutely know my weaknesses. And respect the fact that I do have weaknesses, and that other people have strengths to complement those weaknesses. And designing teams of people that complement each other in that way, to respect each other's skill sets, to really value the fact that this person across the table can do something I could never do at the same level. Of course, we can all do everything a bit, but at the same high, competitive, international level, I can only do a few things. And just having that mutual respect I think is the way to go. So, if industry talks to an academic, they might respect the fact that that particular academic is the world expert in something. And equally the academic needs to realize that they do not have the skill set to take something to market, to understand distribution channels, to understand supply chains, to design value chains, to think about intellectual properties, internal rates of return, all of that stuff. There are other people who are better.

David Glanz: If I said to you you had to choose between being a researcher and an entrepreneur-

Prof Maschmeyer: Right.

David Glanz: Would you be able to make a quick decision?

Prof Maschmeyer: I think it's a question that's unanswerable, because it's not about choice, it's about a continuum, really. And at a certain point, the researcher needs to let the baby grow up and fly the nest as it were. And so, it's not a binary choice, it's a continuum. And I, by definition, am somewhere on that continuum at any time.

David Glanz: So, how are you going about meeting that challenge and making batteries that will satisfy the market?

Prof Maschmeyer: That's a great question, because making a sufficient number of batteries is a real hurdle. Setting up a mass manufacturing line of a first of its kind technology is a large investment. And it needs a lot of engineering support, it needs a lot of financial support, it needs some safety in terms of regulation around that so, does the product that I make fulfill the [inaudible 00:13:06] environment, given that in the battery space in Australia, that has not yet been able to find, that is a risk for any potential investor, et cetera, et cetera. So, we are in the position to

have a great team, to have a great technology, to have a great proven technology that we now need to manufacture at scale. And we're looking at a number of opportunities there in Australia but also overseas with various partners.

Prof Maschmeyer: And this is, I think, where the government can play a role, because most large companies started through some scheme of national emergency, whether it was in war time or whether it was in some other natural or national catastrophe. So I think with a government encouraging manufacture in Australia, we will be well served and the re-orientation of the car industry would be a great opportunity in my view. But currently, we don't see really straightforward paths towards that, towards encouraging Australia's manufacturing industry when it is surrounded by the world's manufacturing economies being a particular challenging. So I think that's something that needs to be discussed also within the economy, how we can, us as engineers and as technical scientists, how can we make our discipline really give the benefit and the fruits of our labor back to the Australian society? And not for it to go overseas and a license deal and we buy back the product that we actually invented.

David Glanz: And what's the next big project?

Prof Maschmeyer: Clearly, I still have a fundamental group of about 15 people, so we do lots of exciting new things, we're looking at antioxidants from seaweed, just had a PhD thesis submitted in that, so we're talking to some companies that are growing seaweed commercially. We're also looking at taking light to split water into hydrogen and oxygen, that's going very well. We're looking at catalysts for electric catalases to again, split water, but this time sunlight from a solar battery. Lots of different things using different types of waste, like waste from the pulp from the paper industry, craft liquor. To make that into aromatics used to make, then, plastics. That's an exciting project. So, lots of different things that are still to come, but for the moment, in terms of the applied space, I've got to get the two companies across the line, that I've got. But otherwise, yeah, still lots to go.

David Glanz: Absolutely fascinating. Thank you so much for your time, congratulations again on your Eureka prize, and success for the future.

Prof Maschmeyer: Thank you very much.