David Glanz: It seems like everyone is talking about the need to deal with the challenges posed by oceans of plastic, but there's been less focus on the toxic waste that's going to landfill. Waste generated by our digital society from cast off mobile phones or discarded computers and the like. If we could recycle materials like silica, titanium, and metals from landfill, it would cut the risk in environmental damage and reduce the need to minors much virginal. My guest today Scientia Professor Veena Sahajwalla is working on doing just that. I'm David Glanz. And I'm in Sydney talking to Veena who is the founding director of the Center for Sustainable Materials Research and Technology or SMaRT for short, at the University of New South Wales. And she is also a fellow of the Australian Academy of technology and engineering. Veena what's the scale of the toxic waste problem, what we're facing?

Prof Sahajwalla: David, you know, the waste around us is actually mind-boggling if you actually stop and think about even your basic humble car tire is a good example of how essential it is in our everyday lives. And we don't even think about it, even though we all have a bust tire every so often and we generate a lot of waste as a result of that. But I think the magnitude of waste generation is enormous. But I think on the other hand, we can just see this as, just materials that are part of our everyday lives. And so I think whether we're talking about cars or electronic devices, I think we're talking about millions and millions of products and devices. So again, you can count them as millions of phones and computers and of course car tires. So I think it is quite a huge, huge challenge. But I think at the same time I love to see it as opportunity. I think it's a tremendous opportunity. And I think as an engineer, I don't shy away from that.

David Glanz: Okay, so there you're saying is like you can't unscramble an egg. But you're saying we can unscramble machinery?

Prof Sahajwalla: Look, absolutely I love the fact that we ... In fact, one of the things we are working on is not quite unscrambling an egg if I could put it that way. But I think it is more about the fact that it is really around unpacking the mega structures that we have. And you can sort of ask the question, to what level do you actually unpack it, so that it starts to become a useful entity? And I think that's really what we have to start to look at. If you got a plastic bottle that can be recycled back as plastic bottle again, then that's great. We collect our plastic bottles, like rPET bottles, and we recycle that. And that's a nice way to look at a macro product that we're used to.

Prof Sahajwalla: But you know, in contrast, you've got something like a car tire, that there's a limit from a safety point of view on how often can you retread a tire before it is actually truly unsafe. So really, it's about saying, can we in fact unpack that whole macro-structure, right down to the micro-levels. And that's really what we are doing. When we talk about recycling, we're actually developing new technologies, which actually go down looking at micro-recycling as part of our new thinking. And this is very much about saying, let's unpack that at the molecular level. And if it means releasing hydrogen molecules from tires, then that's a really fascinating example of how institute inside a steel making process, that's exactly what we have achieved. We have achieved the ability to use tires, in a way that it becomes a really useful part of the steel making process. And that's exactly what our green steel technology that we've commercialized is all about.

Prof Sahajwalla: We in fact, recycled and we like to call it reformed, so many millions of tires, across the world, in our green steel technology. So I think it is very much part of our new thinking that we can indeed go back. And think about those fundamental molecules and elements that actually make up these micro-products, and not just look at it as a plastic or a car tire, and just simply be overwhelmed by it. But rather fundamentally ask what are those building blocks that make up these products. And why can't we just like what we have shown successfully in green steel, why can't we actually utilize those fundamental elements and molecules as part of our process of reforming our waste into value added products.

Prof Sahajwalla: So our greens to technology has been commercialized in many different parts of the world. And indeed, it's such a privilege to be in Australia, but to imagine that a technology that we've developed right here at UNSW in Sydney, has not only been commercialized in Australia, but there are other steel plants in other parts of the world that look at what we've done in Australia and what we've achieved. It's running commercially in UK and South Korea and in other parts of the world. So I think, to me the desire amongst people across the world, is enormous in making this happen for the sake of our planet.

David Glanz: Okay, that's tremendous. Now, the next phase of your work, I know, you talked about the micro-level, and I believe you've now created something called a micro-factory. Now, what does it look like? And what does it do?

Prof Sahajwalla: So David, a micro-factory is really helping all of us understand that at the very fundamental level, we don't need to be overwhelmed and look at just at the micro-product, as I was explaining earlier. But rather to understand that if we were to do micro-recycling, where is the value add in each of these different types of devices and components. Yes, at the high level, we should be looking at the three R's of reduce, reuse, recycle. But we really need to add that forth R to our thinking. The fourth R is about reform. And that basically says that when you can do the low hanging fruit, the three R's that everyone's so familiar with, of course, we should be doing that. But when products get more complex, where you might have different types of metals and polymers mixed up together in one simple device, even a simple example of a printed circuit board, which might have different types of metallics on a board that is of course laid out, the board itself is made of epoxy, and it might be further reinforced with glass fibers, for example.

Prof Sahajwalla: So there's an example of a product that's got metals and epoxy and glass, you can think of simple recycling in that case. And that's why what we're talking about is, what if we could just zoom in and focus in on the elements, and almost design, the whole process of micro-recycling to enable us to get the outcomes we want. So if you want a metal alloy that has got copper and tin in it, you can actually do that by looking at what a circuit board has to offer. If you want some carbon that comes from the polymer, then you can actually once again design your process to allow you to tap into that carbon that you need in a process. And so really, micro-recycling in a micro-factory is very much about, that customization of what recycling should be achieving for you. So looking at very much not as a problem, but rather own as a resource that enables us to achieve our goals of producing metal alloys and producing, silicon carbide, and indeed, silicon carbide is an example of ceramic that we have produced out of a combination of electronic waste glass and plastics.

David Glanz: That's amazing. So, if I walked into a building, where there's a micro-factory, what would I see? How does a chip get fed in? And how does it come out at the other end, what's the actual physical process involved?

Prof Sahajwalla: So in fact, that's the nice thing about a micro-factory. That we have designed it to be very much a modular factory. So there are various modules in a micro-factory, and you might have anything from a robotic arm that helps you in the initial part of identifying the various components and parts and picking up the various parts, kinds of things that we're just used to seeing these days in so many different applications. So yes, using robotics and cameras and systems up front, that could be part of it. But I think the heart of the process very much lies in understanding how, for example, we might operate a furnace, that would actually be quite selective in the way it runs at various temperatures.

Prof Sahajwalla: So it's not just about having one big mega furnace that's tuned to one set temperature, and often goals, but rather, in a micro-furnaces it's about being able to customize the temperatures at which the furnaces could operate. And of course, the advantage of doing that is that you can then select what you want to make. And you might be selective in saying, right, today, I want to be able to operate it at 400 degrees celsius, because I'm making a rather low temperature alloy. And in fact, the next week, I might basically fine-tune that temperature setting to take it up to 1000 degrees celsius, because I might want to produce a copper-tin alloy, where I might selectively have control on the chemistry of the alloy that I want to make. So it's really very much about picking the kinds of modules that you want to have in a micro-factory.

Prof Sahajwalla: And then of course, somewhere in there is also one module that is able to take all the leftover bits of plastic from my printers, for example, because they might be a whole lot of old printers coming along, as we know, we have in our homes and offices. And to be able to convert those printers, for instance, into plastic filaments that then allow us to create this really value added plastic filament out of the plastics that we don't give second thought to our printers when we're done with it. So the ability to have various modules that actually do different things for us, is what makes it so exciting. Because in a micro-factory, I can actually decide which modules I want to work with. But I can almost imagine that I create and work with, in this other industries, and I collaborate with other industries and have this ecosystem where if I want to do plastics, but the guy next door has got effectively a micro-factory that might have a furnace module, effectively I can pass that on, that circuit board with a lot of metals in it to somebody else who in their micro-factory might process metal alloys.

Prof Sahajwalla: So the ability to create an ecosystem, I think, to me is really fascinating. And I think to me, it's starting to touch upon that whole vision of what a shared economy might look like. We don't have to see the burden of all of this as individuals or individual factories and processes, but rather that shared economy, and enabling us to really be collaborative in the approach that we take. And I think to me, that would be the ultimate utopia that I'm dreaming of, in what various micro-factories could collectively achieve.

David Glanz: The way you described them, they sound fairly sophisticated technology that's involved. How easy would it be to roll out this model into, say, developing parts of the world where people have fewer resources, but lots and lots of leftover mobile phones, for instance, since mobile phones are now ubiquitous. How easy would it be to take this technology and take it into a developing economy?

Prof Sahajwalla: Very good question, David. Because I think to us, really that's the vision of micro-factories. We want to have it so that it is accessible, and more importantly, affordable for every part of the world, whether you're in a developed economy, like in Australia, or in developing parts of the world. And indeed, over the last week, as I have been presenting in places like Dubai, where I've had so many people, for instance, from India and Africa, who were present at the innovation forum, and indeed, were asking exactly that, we'd love to be able to have these micro-factories. And I think to us the fact that it's been configured exactly as a modular system. So that you can literally pick the modules that you can afford, and pick the priorities. So someone sees plastics as a big problem. They can literally say, look, I have got systems in place for my metals, but you know what, really with plastics, a lot of people are burning plastics, that's causing pollution that's causing health problems.

Prof Sahajwalla: We are already looking at how that could be deployed in so many developing parts of the world. That's not about making money, per se, but that's really addressing a huge social challenge. So to me, the important part of why we're doing this is not just about the economic driver, yes, it's nice to be able to have technologies earning money. But I think to us, the nice thing about micro-factories, is in many developing economies, where there is such a dire need to deal with waste plastics and they can't afford the most sophisticated solutions. Micro-factories are exactly that, they can actually be deployed on a small enough scale and many, many modules can be deployed in many small communities and cities where people have no other solution, but to simply burn away plastics.

Prof Sahajwalla: And I think to us, that's really in a way, a sad consequence of the whole new electronic age. And I'd love to think about where we're at in terms of what the future holds for us. Is a nice thinking around what a whole new circular age might look like, if I can call it that, David. A circular age that allows us, all of us on this planet, to be part of the circular economy. But really, to enable us to not only deal with our end of life products, see them as resources. But equally importantly, generate revenues, of course deliver new economic opportunities, but at the same time, deliver on environmental as well as social benefits for everyone on this planet.

David Glanz: That sounds like a great vision. So that fourth probably means you're not a favorite amongst the mining companies. They can say their sort of demand beginning to taper off as in when your idea takes wing. Are you happy to wear the label of this disruptor?

Prof Sahajwalla: I'm very happy to wear the label of a disruptor David. I mean, I think from my point of view, I have never been the sort of person to follow the norms. In fact, I'd probably say right from early childhood, it's been very much about being a disruptor, being a little bit of rebel. I'm sure my parents would also label me in that same way. So I think the fact that I ended up doing engineering in India, where I think not too many girls would have taken that up. And in fact, it would have been seen as quite an odd thing to do for a young girl. So I think to me, the fact that there are many, many young women coming along, and indeed, the whole face of how we define, how engineers, and people who love technology can really disrupt our thinking, I think is fantastic. And if I'm labeled as a disruptor, I think I would absolutely love it. Because I think to me, that's what being an engineer should be all about.

Prof Sahajwalla: It's about technology, it's about society, it's about environment, it's probably one of those few professions where we can actually deliver a holistic view of the world. And I think we can use technology and science and engineering, and the whole package to deliver so many benefits, environmental benefits, social benefits, and of course, technological and economic values and benefits. So the fact that waste of value is something that we are creating as a way of thinking where technology comes in as a true disruptor going beyond normal recycling, into micro-recycling and micro-factories as the technology platform to deliver that. I think to me, it's a fabulous way for Australia, to be leading the world and showcasing to the world, what we're able to do. And the fact that we're doing this in Australia and commercializing these technologies, we're on that journey. I think I absolutely love the fact and I'm looking forward to the journey.

David Glanz: Fantastic. Well, thank you very much for your time Veena. And hopefully we'll talk again sometime.

Prof Sahajwalla: I'll look forward to it. Thank you so much for having me David.