BIZCOMMUNITY

Steel from old tyres and ceramics from nutshells - how industry can use our rubbish

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If someone said "green manufacturing" to you, what comes to mind is probably environmentally friendly products - solar panels, bamboo garments and the like. But there's much more in this space. In fact, far greater environmental and economic impact can be achieved by looking further up the manufacturing chain.

There is huge potential in rethinking the energy and raw materials that go into our favourite and essential goods.

What I am talking about here is waste. What if we could turn rubbish into an input? Instead of viewing waste as a growing global burden, we could “mine” the world’s landfills – by using old tyres to make steel, for instance.

We’ve got a huge problem with waste

Globally, waste is becoming a huge problem. There has been an eightfold increase in materials consumed over the past century. There are several reasons for this: rapid industrialisation across Asia and other developing nations; the shortening of product replacement cycles; and the dramatic fall in the prices of consumer goods and an accompanying rise of consumer cultures.

The world’s three billion urban dwellers generate an average of 1.2kg of solid waste per person per day, according to the World Bank. Without innovation, landfills around the world will become increasingly clogged, exacerbating the loss of potentially valuable secondary resources and risking environmental contamination.

So let’s view this increase in waste as an opportunity. Around the world, the cost of raw materials are on the rise. Rethinking waste might help us solve both problems at once.

Rethinking waste

Our waste streams are becoming increasingly complex – mixed plastics, e-waste and auto waste, for example. As such, a lot of it simply cannot be recycled using conventional approaches like sorting through rubbish to extract glass and then

recycling that into more glass. This phenomenon is another reason why our landfills are filling up.

But with new approaches we can overcome this. We can look at waste at the elemental level. The world's waste mountains are packed with useful elements like carbon, hydrogen, silicon, titanium and other metals that we would otherwise have to source from virgin raw materials.

By identifying and processing these valuable elements, and redirecting them back into our industrial processes, we can simultaneously solve the problems of waste and the skyrocketing cost of inputs.

Some examples of waste in action

At UNSW's SMaRT Centre we have been researching ways to reuse waste. So far we have achieved success in introducing waste polymers, mostly old tyres, as slag foaming reagents in electric arc furnace (EAF) steelmaking, a chemical reaction which is significantly important in EAF – just as in a cappuccino or a beer, the foam is crucial to a good-quality product. This process not only reuses a waste material, but improves energy efficiency, and reduces emissions and demand for non-renewable coking coal.

We have also recently published results of our research into the substitution of green petroleum coke with the waste shells of Australian macadamia nuts in the production of high-value silicon carbide and silicon nitride – super-hard ceramics that can be used for a range of applications from medical devices, to drilling tools, high-temperature engine linings for performance cars.

We discovered that macadamia shell waste, tens of thousands of tonnes of which are thrown away in Australia every year, is an excellent source of carbon with a very low ash content. This means less impurity, and hence cheaper costs for removing these impurities when replacing conventional coke.

Into the future

But it doesn't end there. There is so much waste for which we have no answer yet. Every year tens of millions of vehicles are decommissioned, for example. While the metals that make up about 75% of a vehicle by weight can be readily and profitably recovered and recycled, the remaining plastics, glass, composites, complex materials and contaminants are mainly destined for landfill. For every car, some 100-200kg of complex and potentially toxic waste ends up as "automotive shredder residue" (ASR).

This poses a growing technical and environmental challenge worldwide, and represents a significant waste of finite resources.

We are investigating a range of transformations using ASR, including new pathways for creating alternative resources for the production of ceramic materials like silicon carbide and titanium nitride composites, produced using the silicon and titanium found in these residues. Instead of using conventional raw materials, like silica from quartz or carbon-bearing

resources such as coke, waste automotive glass and plastic can be used.

This is just the start of reusing waste. There are still great advances to be made by combining these recovered resources with new modes of manufacturing. Imagine combining the ability to reform plastics with other new developments like 3D printers. In future we may use waste as an input that will enable us to locally print off something new, fully closing the materials loop.

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