Making flexible crystals and new separation technologies

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Video:

For creating flexible crystals that can be bent and twisted and discovering new separation technologies, Associate Professor Jack Clegg received the $50,000 Malcolm McIntosh Prize for Physical Scientist of the Year.

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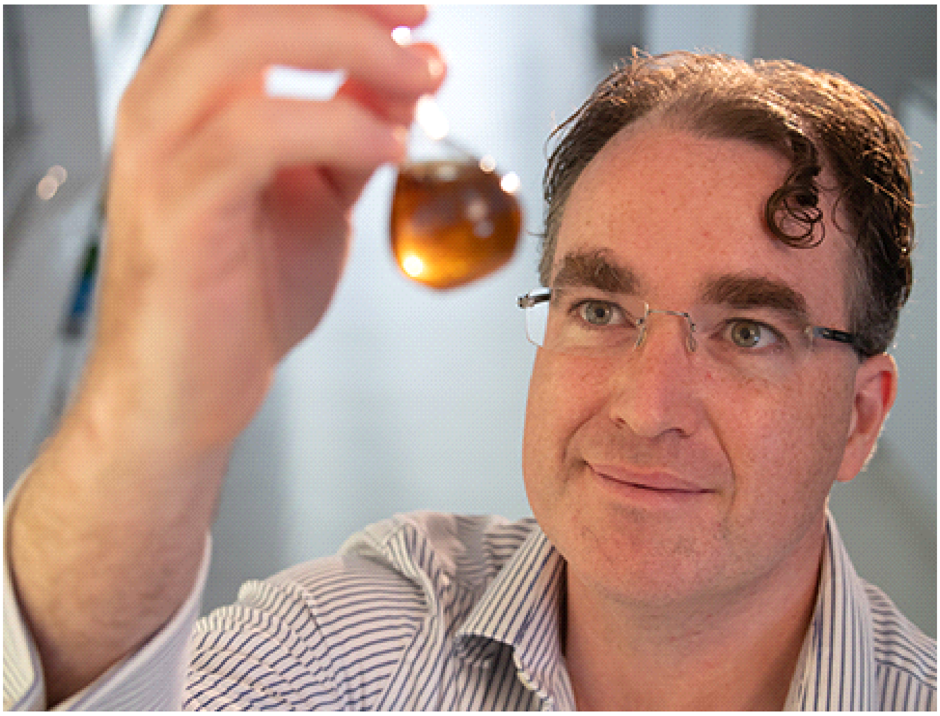

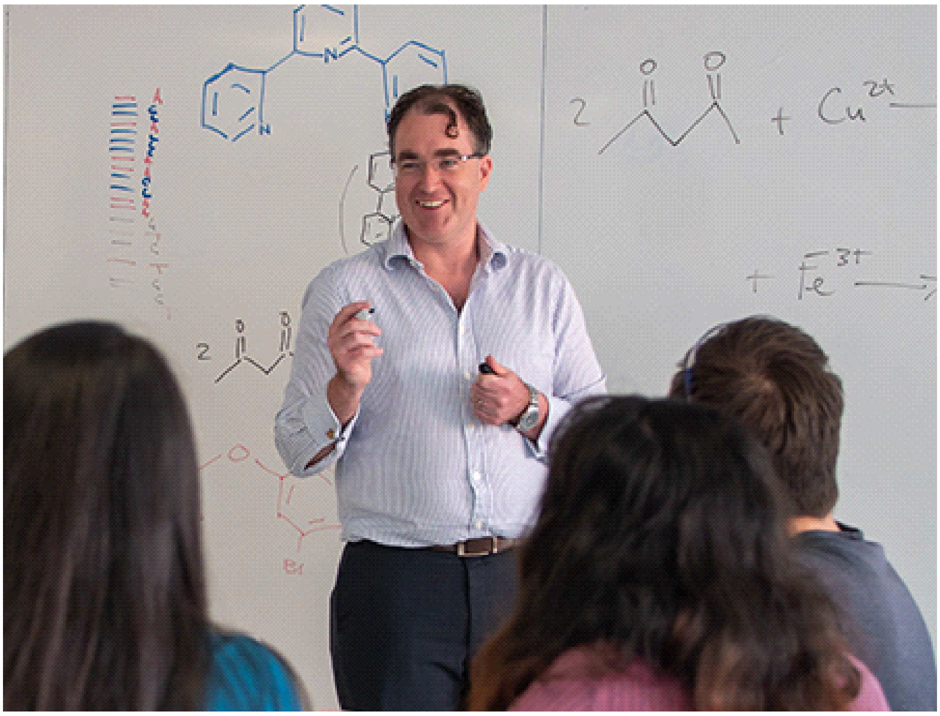

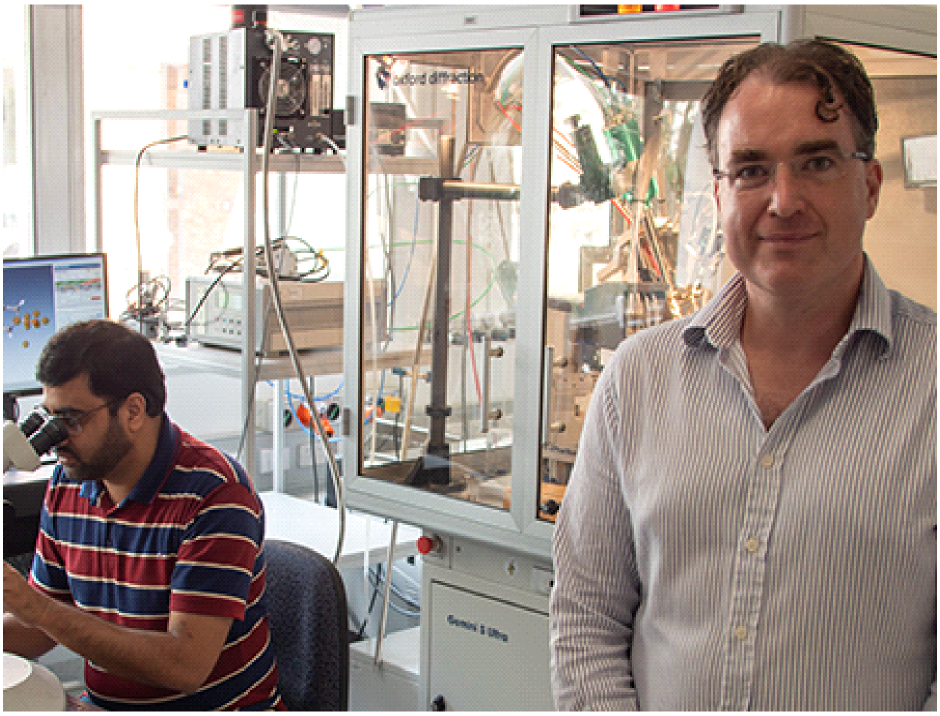

Our smartphones, like all modern electronic devices, are packed with crystal semiconductors. When we drop them, it's not just the screen that breaks. Crystals as we know them are brittle, but that will change in the future. Associate Professor Jack Clegg has designed new kinds of crystals that are so flexible you can tie them in a knot. These crystals use common elements such as iron, copper, carbon, oxygen and hydrogen.

He has also created molecules that can be customised to act as sieves for a vast range of manufacturing processes from the oil industry to water filtration and pharmaceuticals. He hopes the first applications will be in drug production where much of the cost of making new drugs is in the purification process. About 15 per cent of the world's energy use is for separation processes, so more efficient technologies will find eager customers.

"What I really love about chemistry is it's a little bit like a cross between playing with Lego and cooking," says Clegg.

"We can design very complex molecules from simple building blocks and then get into the laboratory and cook them up. It requires creativity but also hard science."

That's a big change for chemistry. In the past chemists would 'cook' first, then find out what they'd made. Today they can design materials in the computer, then make them in the laboratory.

That's what he has done. He has taken commonplace elements like copper, iron, carbon, hydrogen, and nitrogen, and combined them to create two kinds of complex chemicals that have real applications in the industry.

His first achievement is to make crystals that are so flexible that he can tie a knot in them. Why is that useful? Electronic devices use crystals for everything from interacting with radio waves to semi-conductors.

"Electronics relies on crystals," says Clegg.

"But crystals are inflexible. If you bend them, they break. If you drop your phone it's not just the screen that breaks. Often the crystals inside the phone break as well. And many components in a smartphone require rare-earth elements."

"If we can engineer these crystals to be flexible, this opens up applications in a much wider range of technologies such as electronics that we might be able to wear, twist, or bend."

His second achievement is to create 'cage molecules': large, designed molecules that have holes inside them that we can selectively put smaller molecules into. These structures can function as precise molecular sieves. They can, for example, separate almost identical molecules such as the left-handed and right-handed forms of drugs. Purification is one of the most expensive stages of drug manufacturing, so Jack anticipates that this technology will be welcomed by pharmaceutical companies.

The technology has potential wherever molecules are being separated.

"About 15 per cent of the world's energy production currently goes in the purification of industrial chemicals," he says.

"Separation technologies are used everywhere from purification of crude oil through to mineral separation, water treatment, and thousands of manufacturing processes."

However, Clegg's creations still have a way to go before they reach the market.

"One of the hardest parts about doing fundamental chemistry research is how long it can take to make proof of concept discoveries," he says.

"We've got to the stage where we can show that these materials are going to be really useful. Now we need to engage with industry to engineer them to be useful in a real industrial setting."

He sees the Prize as an opportunity to remind people of the role of chemistry in society.

"Chemistry underpins our way of life. We're made from chemicals, and chemistry is central to most industrial processes and really just about everything we do.

"It's a bit hidden, though. Everybody thinks that chemistry is hard and maybe a little bit dirty. I hope this prize will allow me to highlight the real technologies we can develop with chemistry for the benefit of the Australian people."