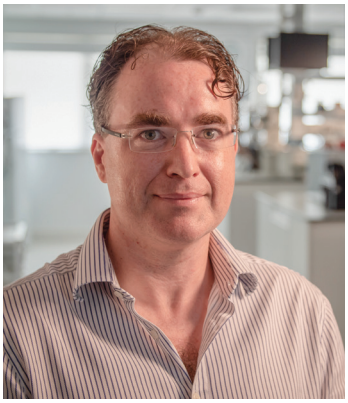
Australian Government

THE PRIME MINISTER'S PRIZES FOR SCIENCE

JACK CLEGG

MALCOLM MCINTOSH PRIZE FOR PHYSICAL SCIENTIST OF THE YEAR



Making flexible crystals and new separation technologies

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.

For creating flexible crystals and new separation technologies, Associate Professor Jack Clegg receives the $50,000 Malcolm McIntosh Prize for Physical Scientist of the Year.

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

"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 Jack 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 Jack.

"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."

Jack's 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.

Jack's 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.

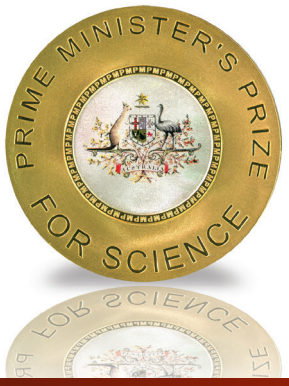
"Separation technologies are used everywhere from purification of crude oil through to mineral separation, water treatment, and thousands of manufacturing processes."

However, Jack'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."

Jack 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."

Further reading

https://researchers.uq.edu.au/researcher/2754

https://theconversation.com/crystals-like-youve-never-seen-them-before-theyre-flexible-83148

Career profile: Jack Clegg

Qualifications

2014	Graduate Certificate in Higher Education, University of Queensland
2009	Bachelor of Laws with Honours, University of Sydney
2008	PhD, University of Sydney
2004	Bachelor of Liberal Studies with Honours, University of Sydney

Career highlights

2016	Young Alumni of the Year, Faculty of Science, University of Sydney
2014	UQ Foundation Research Excellence Award, University of Queensland
2012–ongoing	Lecturer, Senior Lecturer and Associate Professor of Inorganic Chemistry, School of Chemistry and Molecular Biosciences, University of Queensland
2011–2012	Director of Studies, Emmanuel College, University of Cambridge
2010–2012	Marie Curie Fellow, The Department of Chemistry, University of Cambridge
2008–2010	Postdoctoral Fellow, School of Chemistry, University of Sydney
2009	Convocation Medal, University of Sydney
2008	Vice-Chancellor's Award for Enriching the Student Experience, University of Sydney
2004–2008	PhD Student and Postgraduate Teaching Fellow, School of Chemistry, University of Sydney
2007–2008	President, Sydney University Postgraduate Representation Association
2004–2006	Fellow of Senate, University of Sydney
2004	Henry Bertie and Florence Mabel Gritton University Medallists Award, University of Sydney
2003	University Medal, University of Sydney
2002–2007	Director, The Australian Youth Orchestra Ltd