A pure water future

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CSIRO research scientist Dr Dong Han Seo has made groundbreaking discoveries that could solve the global problem of water scarcity and provide clean drinking water for millions of people around the world.

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The United Nations estimates a staggering 700 million people in 43 countries don't have enough water. So, a radical water purification discovery by Australian researcher Dr Dong Han Seo couldn't have come at a better

time

Seo has invented a water filter made from graphene, a material that is traditionally impermeable to water.

“This is seriously cutting-edge science and research, no one else in the world has made this sort of discovery,” he says.

At the helm of the Graphene Membranes team at Australia’s independent science agency CSIRO since 2015, Seo has been working on developing a low-cost graphene synthesis process.

Graphene is a semi-metal which caused much excitement in 2004 when a team of scientists at the University of Manchester isolated a single atomic layer of carbon for the first time.

It was being touted as a material that could change electronics forever.

“Graphene conducts electricity better than copper, it can conduct heat better than any thermal conductor and it’s 100 times stronger than steel,” Seo says.

“So initially people thought it could revolutionise diverse fields, including electronics.”

“But…one of the the intrinsic problems with graphene is the cost and complexity of creating it.

“And most importantly, there’s no easy adoption of the material – there’s been no killer application,” Seo says.

Until now...

Turning waste into graphene

The first challenge Seo and his team needed to overcome was cost.

The standard way of “growing” graphene involves using highly explosive, expensive gasses in a pressurised environment at very high temperatures, for hours.

Not only is it difficult to find people with the right expertise to handle the potentially dangerous gasses, the cost of heating them to 1000°C for many hours in vacuum processing is immense.

“So I tried to think about a way to get rid of all the precursor gasses needed to grow the graphene,” Seo says.

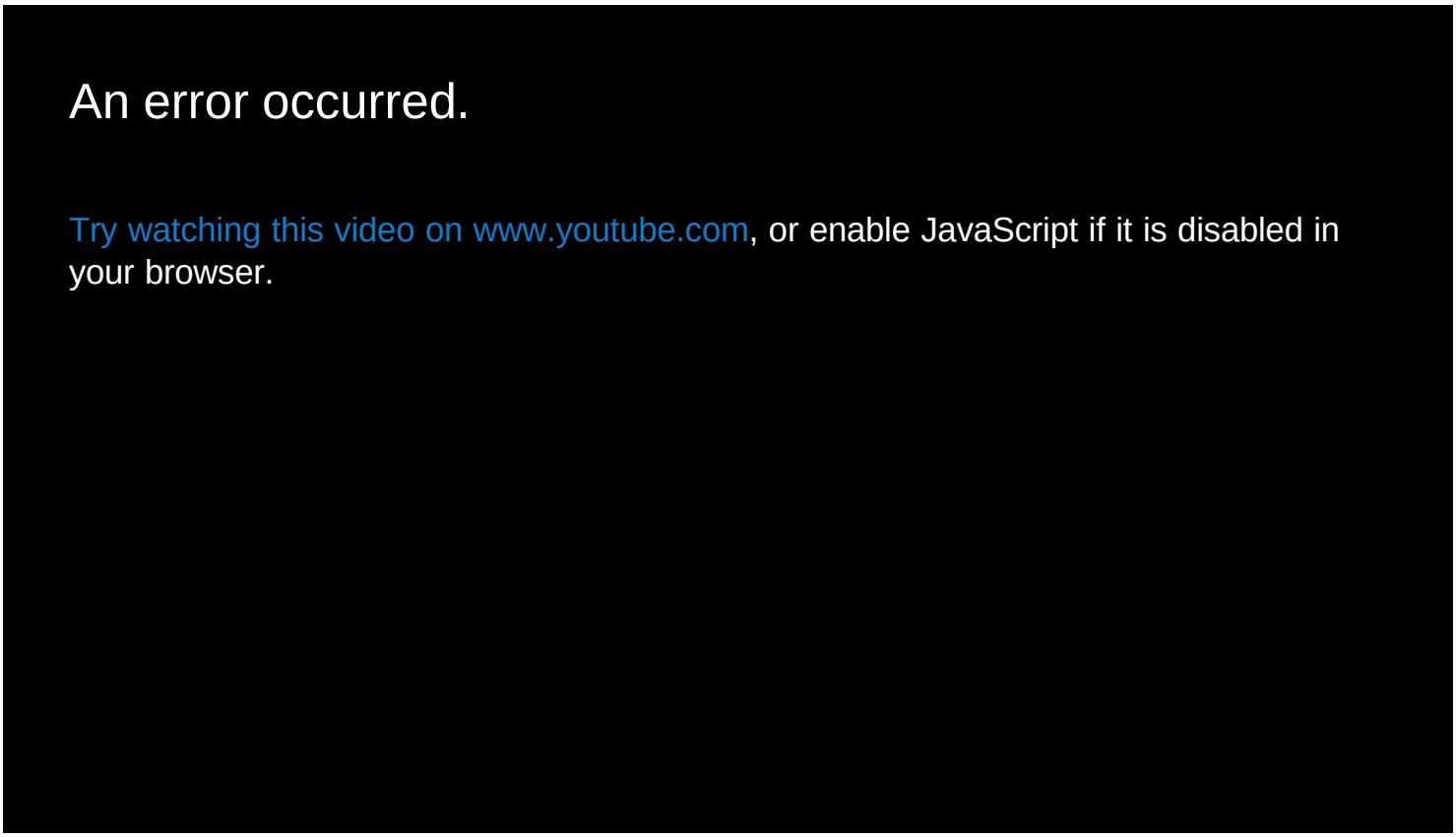
After studying the hydrocarbon chains of various gasses and comparing them to cooking oil, he made a brilliant discovery.

“When I thought about it I was like ‘wow’....this oil, which is basically a fat and has the right kind of carbon chain, could actually replace all the expensive gasses which are currently used.”

After many experiments in 2015, they found most types of waste cooking oils, as well as any renewable oil such as soybean oil, could be used to make graphene.

Recycling these oils was much better for the environment and for the budget, with a cost of about $2 a bottle, rather than $1000 for a single gas bottle.

Seo's new 'GraphAir' method of growing graphene takes only 30 minutes and uses the renewable oil, as well as ambient air, rather than a vacuum process.



Groundbreaking water purification

Seo's team then joined forces with the Water Purification Centre at the University of Technology Sydney (UTS) and Victoria University, and discovered that unlike most graphene, the one made using the GraphAir process is not impermeable to water.

"It's supposed to be impermeable to water and some forms of gasses," Seo says.

"But what I found is our graphene can permeate water, while rejecting the salts and chemicals."

Warm, dirty water passes through GraphAir filter, and completely safe and clean drinking water comes out the other side. Even water taken from Sydney Harbour was rendered drinkable using the filter!

The GraphAir filter never gets clogged or dirty, nasty chemicals can't damage it and it purifies more effectively than other commercially available filters.

"We're yet to find something that can destroy our GraphAir membrane," Seo says.

Building a prototype

The CSIRO team is currently looking for commercial partners to create bigger sheets of GraphAir to build a prototype system, which could recycle wastewater for individual buildings and precincts.

“The world is moving away from building huge desalination and water treatment plants because of the cost and environmental impacts,” Seo says.

Most reverse osmosis water treatment plants require large amounts of energy to run, and the desalination process results in salty, briny waste.

“There’s a move towards smaller, more environmentally-friendly water treatment options for individual buildings and we think GraphAir could be perfect for that.”

Global impact

There’s also potential for GraphAir to be used in developing countries to transform dirty, dangerous water into clean, drinkable water.

According to UNESCO, by 2025, 1.8 billion people are expected to be living in countries or regions with absolute water scarcity, and two-thirds of the world population could be under water stress conditions.

Already, millions – mostly children – die from diseases associated with inadequate water supply, sanitation and hygiene every year.

Seo is deeply motivated to make clean water available to all that need it.

It is a brilliant ambition for someone who claims he was an “ordinary” student.

Seo completed a Bachelor of Science alongside a Bachelor of Commerce at the University of Sydney – a combination of knowledge which he says serves him well when considering how to commercialise and scale up his innovations – and then went on to do a PhD focusing on graphene.

He’s been in Australia for 16 years now, after moving to Sydney from Seoul, alone, in 2002 at the age of 17 to complete his final year of high school.

“My parents always wanted me to be part of a global world, rather than just staying in South Korea,” he says

Their dream – and his own – is now coming to fruition through his GraphAir work with CSIRO Manufacturing, with plans to commence field trials in a developing world community in 2019.

“I want to do something of great impact in a beneficial way to society and the world,” he says.
