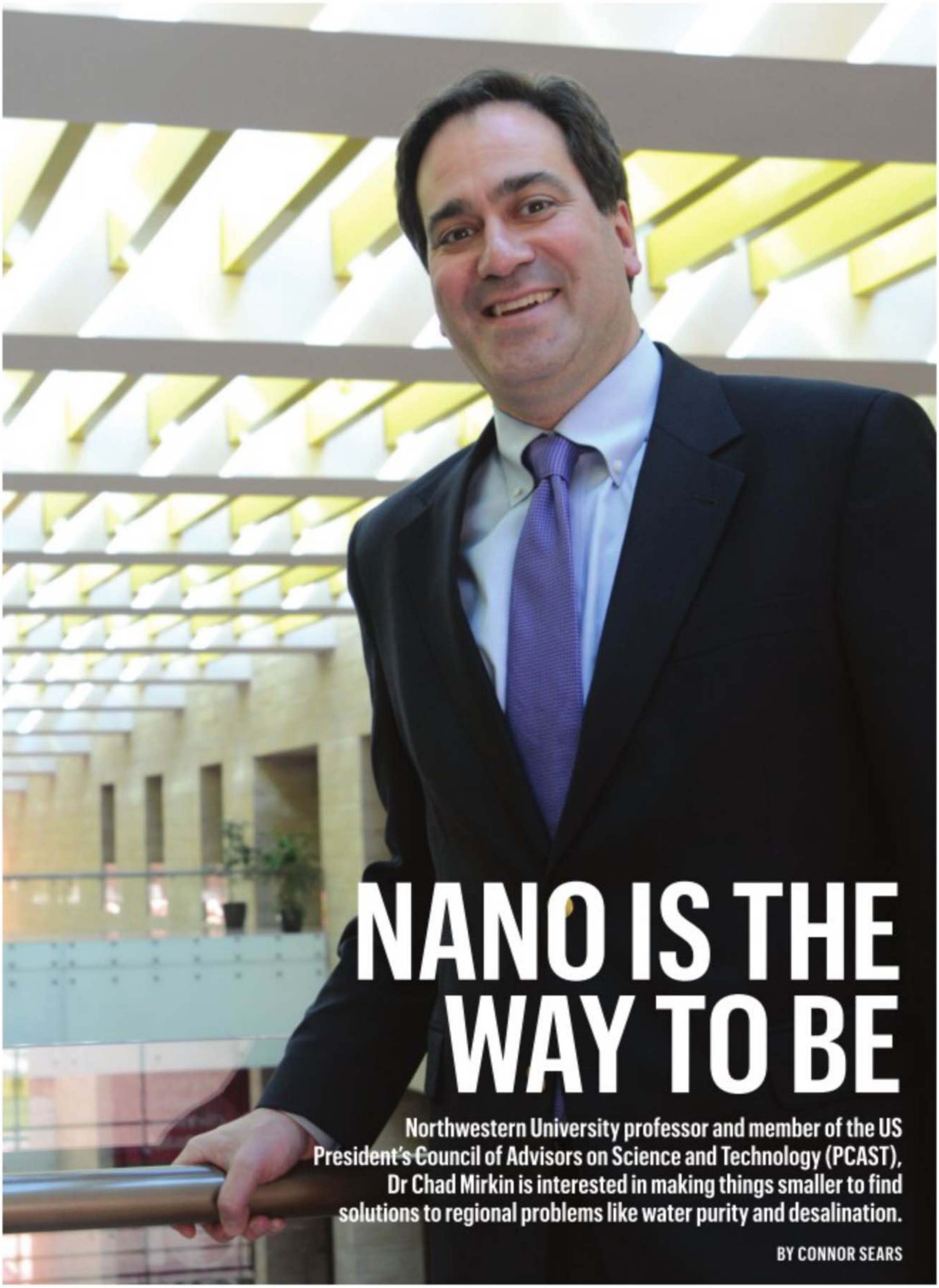

NANO IS THE WAY TO BE

Northwestern University professor and member of the US President's Council of Advisors on Science and Technology (PCAST), Dr Chad Mirkin is interested in making things smaller to find solutions to regional problems like water purity and desalination.

BY CONNOR SEARS

In this day and age, much scientific and technological advancement involves making things smaller. Computer engineers work to create smaller processors that allow laptops, tablets and mobile phones to shrink down without sacrificing processing power. Smaller memory storage systems mean that we can now carry more data around in our pocket than researchers 20 years ago could have stored on a stack of 50 CD-ROMs. In medicine, smaller tools are constantly being developed to provide patients with safer and less invasive surgery options. Northwestern University professor Dr Chad Mirkin is also interested in making things smaller, but his research takes the practice to a whole new level. It doesn't get much smaller than creating structures one molecule high.

Dr Mirkin is an engineering professor and the director of the International Institute for Nanotechnology (IIN) at Northwestern University's main campus in Evanston, Illinois. The institute contains $600 million worth of research and educational infrastructure, all focusing on nanoscience, the practise of working with materials billionths of a metre in size.

"One of the tenets of nanotechnology is that everything when miniaturised is new," Mirkin says. "It has new properties. When you take gold and you shrink it down to the 13 nanometre scale, it's no longer gold in colour. It's red in colour. The way it interacts with light is completely different. Its chemistry is completely different."

Nanotechnology has practical applications in many different fields. Everything from optics to energy can be affected by these minuscule structures. Even regional problems, like the issue of water purity and desalinisation in Qatar, can be tackled more efficiently through nanoscience.

Another important field for nanoscientists is medicine. The most important development to come out of the IIN, Mirkin says, is what are called spherical nucleic acids, tiny balls of DNA that can interact with cells in ways totally unique from regular, linear strands of DNA. These spherical nucleic acids can selectively bind to certain types of cells and, as he puts it, "flip genetic switches". This technology can be used to target and attack diseases like, in his example, brain cancer. Using this process, the IIN saw tumour reduction and increased survival in animals with the disease, a promising first step towards new cancer treatments that Mirkin presented to the second Middle East Conference on Biomedical Engineering held in Doha.

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"So this is a very powerful form of what's called gene regulation technology," Mirkin says. "That can be used, in principle, to begin to treat some of the world's most debilitating diseases."

Another advancement that has come out of the IIN is a process called Dip Pen Nanolithography, which allows tiny structures one molecule high to be drawn on a surface. In line with many other impressive scientific discoveries, this invention happened completely by accident. A student had left the tip of an atomic force microscope (AFM) – a tool that allows researchers to measure surfaces down to the atomic scale – in contact with a surface while he went outside to smoke a pipe. When he returned, he found that a tiny amount of water had condensed from the air and had been deposited on the surface by the tip of the microscope. He then found that he could create patterns by moving the tip of the microscope, patterns that could be only a few molecules high. Because these patterns were made of water, though, they would soon disappear.

"I said, look, the world's only going to care so much about making what we called metastable patterns of water," Mirkin says. "A chemist really wants to build things, so let's put molecules on there that will chemically react with the surface and form a layer that stays there forever."

Mirkin's team then designed chemicals that would react with a gold surface. Then, by utilizing not one but millions of AFM tips, they were able to create larger patterns with a molecular level of resolution.

The IIN acts as a centre of international cooperation in pursuit of advancing nanotechnology. As the largest institute of its kind in the world, it attracts great scientific minds from across the globe. Mirkin's team alone includes researchers from 13 different countries, and there is much more room for international collaboration outside of the United States. The institute has set up sister centres in several international locations like China and Singapore that not only help to develop human talent in the field but also increase the potential for collaboration on projects that can affect populations all over the world.

Whether the gulf region, or even Doha in particular, could be able to join in this global partnership is still up for discussion.

"This region is poised to have the first nanomedicine and nanotechnology centre of its kind, and we're exploring whether that's a possibility and whether Qatar is the best place to establish it," Mirkin says. "That's going to be a dialogue that takes place over the next few months. We will either see a synergy or not and move forward or not."

In addition to advancing the field of nanotechnology, Mirkin has also been involved with making policy recommendations to the American government as a member of the President's Council of Advisors on Science and Technology (PCAST) since 2009. PCAST is a group of the best and brightest minds from scientific and technological fields in the United States who meet to recommend policy to President Barack Obama.

"It's intellectual gymnastics," Mirkin says. "These are meetings where you've got, when I started, three Nobel Prize winners on the committee. There are several of the most accomplished university presidents. There are guys who revolutionised Wall Street, guys like D E Shaw. There are people who had built unbelievable businesses, Eric Schmidt of Google and Craig Mundie, one of the smartest guys out of Microsoft. They are giants in their field. They're people that have an unbelievable set of credentials and accomplishments yet a desire to give back through their service to government."