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NTU, NUS push materials science frontiers

Universities use cutting-edge tech to create new nanomaterials

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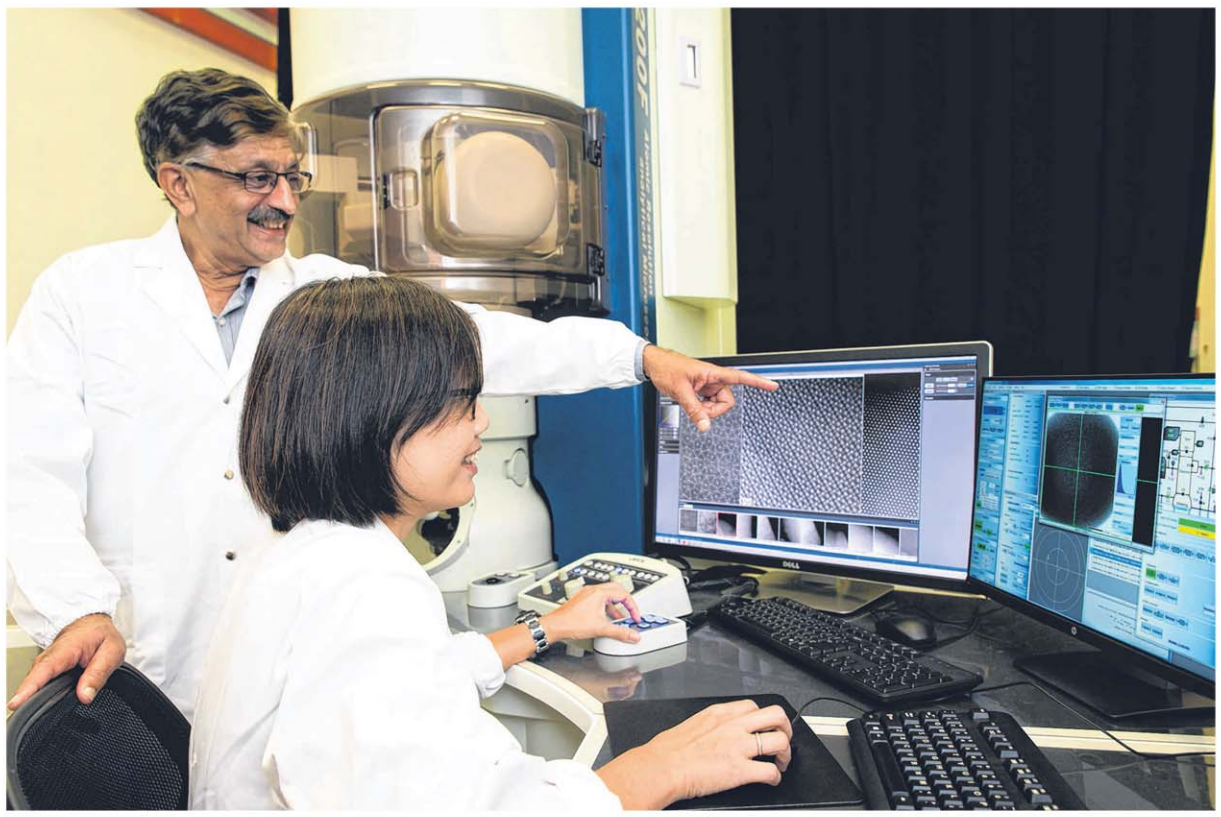

Left: Professor Subbu Venkatraman, chair of NTU's School of Materials Science and Engineering, and Associate Professor Lam Yeng Ming with a transmission electron microscope used to analyse materials at the nanoscale. Right: The machine developed by TERA-print that can test 11 million materials simultaneously. PHOTOS: NANYANG TECHNOLOGICAL UNIVERSITY, NORTHWESTERN UNIVERSITY (USA)

From a "rubber stamp" that produces 11 million different nanoparticles at a time, to a supercomputer that runs round the clock churning out potential new nanomaterials, Singapore's two main research universities, Nanyang Technological University (NTU) and National University of Singapore (NUS), are pushing back the frontiers of materials science.

With millions of dollars being invested, new materials that seem to be from science fiction movies are being developed .

The Programme on Combinatorial Materials is a collaboration between NTU and Northwestern University in the United States. It will be hosted at NTU's Materials Innovation Centre, which will be launched next year.

NTU is pouring US$20 million (S$28.5 million) into the effort over the next few years and will be one of the first places in the world with a new US$160,000 machine that can create and test new nanomaterials many times faster than existing methods.

Such materials, which are made of tiny components, could have uses for everything – from medicine that is absorbed more effectively by the body to cling film that changes colour when the food goes bad.

Northwestern University's Professor Chad Mirkin said that humans have discovered less than 0.1 per cent of the possible kinds of materials in the world.

"Everything that we do relies on new materials and the properties that come with them," he said.

"Imagine what would be possible if you could rapidly look at all these different possibilities, systematically adjust and fine-tune, and find the materials that are perfect for the application you're interested in."

The machine at NTU, made by Prof Mirkin's spin-off company TERA-print, features a polymer "rubber stamp" no more than about 7.6cm across. It can simultaneously print up to 11 million dots – all made of different materials.

Once the print is made, researchers can apply reactants over it to see which dots give the desired reaction. This effectively tests 11 million materials simultaneously – rather than just one at a time.

But it is not just a matter of having the latest "toy". The people who use it are even more important, said NTU Provost Freddy Boey.

"Singapore has totally succeeded in attracting top talent that are interdisciplinary... you talk about water, we have them; you talk about electronics, we have them; and energy and so on," Professor Boey pointed out.

This is also the case at the NUS Centre for Advanced 2D Materials.

The centre is utilised by about 50 professors and 200 scientists from different disciplines, said Professor Antonio Helio Castro Neto, the director of the centre.

It is the place to be for researchers interested in sheets of material that are around the thickness of an atom.

These are considered nanomaterials as at least one of their dimensions measures 100 nanometres or less. (A nanometre is a one-billionth of a metre).

These two-dimensional materials have anti-icing, anti-fouling, anti-bacterial and anti-corrosion properties, among others, making them useful for industries like aerospace , electronics, biomedical and paint.

"It's huge...we know by now more than 2,000 of these materials. We don't know how many of these 2D materials exist, but we know it's a huge number," said Prof Castro Neto.

In fact, his centre is participating in the Materials Genome Initiative led by the US to accelerate the discovery and use of new materials.

Instead of applying reactants to test materials like NTU does, NUS uses supercomputer simulations to accurately predict the properties of materials, and then selects those with the desired properties for laboratory synthesis and testing.

One of the materials Prof Castro Neto's group discovered from the computer simulations is tin sulphide, which is a good semiconductor.

When combined with graphene – another 2D material that conducts electricity well – scientists could potentially make paper-thin smart devices that can be rolled up.

The researchers are also experimenting with tiny solar cells made of the same materials, which Prof Castro Neto said could eventually be used in paint to generate electricity off walls.

Singapore will have the upper hand in using all this technology.

"NUS owns this technology. This is where Singapore can really make money from its intellectual property because it's owned by the country. It's part of the wealth of the society," said Prof Castro Neto.

The two universities enjoy a high standing in the materials science world.

NTU was ranked sixth in materials science by the QS World University Rankings this year, while NUS was ranked eighth.

But there remains a mismatch here between technology and its production.

"We don't yet have the capacity to push the technology being produced here and turn it into industrial wealth," said Prof Castro Neto.

Dr Lerwen Liu, managing director of Singapore-based nanotechnology consultancy firm NanoGlobe, said the link between research and industry is still not as strong in Singapore.

This is especially the case when compared to countries like Japan and Germany.

There are, however, some signs that this is changing.

Samsung and Lockheed Martin are interested in his centre's work, said Prof Castro Neto.

Three multinational companies have also expressed interest in the NTU-Northwestern University initiative.

One pharmaceutical company even committed a "seven-figure" sum, said Prof Mirkin.

Dr Liu said: "Commercialising the research – the scaling up – takes money. And this is the part that will change the lives of people."

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