

Nanotubes in a pattern

by David Salt

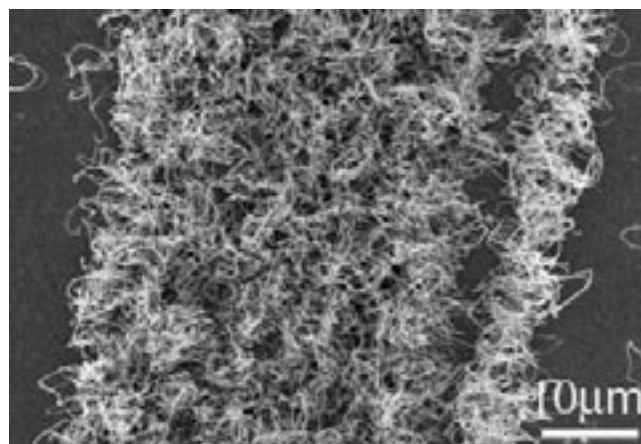
The letters A, N and U pictured below right are each just under a millimetre in width. That's small but not particularly noteworthy. However, when you ramp up the magnification a couple of orders of magnitude the magic of the letters starts to become apparent because these letters are actually composed of millions of nanoscale hairs or tubes growing out from scratches on the surface of a silicon wafer.

In a world first, researchers at ANU have grown carbon nanotubes on top of a scratch on a silicon wafer. The work was carried out by Dr Ying Chen and his team in the Department of Electronic Materials Engineering (Research School of Physical Sciences and Engineering).

"Growing large quantities of carbon nanotubes on predesigned patterns and at desired locations on different

substrates is an important part of integrating nanotubes into nanoscale devices and sensors at a commercial scale," says Chen. "While there's been some success growing nanotubes on silicon dioxide substrates primed with metal catalysts using chemical vapour deposition, it hasn't been achieved on pure silicon substrates."

Ying Chen's team achieved the feat using the ball milling technique that Chen has developed in recent years. Ball milling involves grinding the precursor materials that will make the nanotubes into an ultra-fine powder in a revolving chamber full of ball bearings. In this case, a couple of grams of iron phthalocyanine (a material that



The three letters A, N and U shown here are each composed of millions of carbon nanotubes (pictured above) grown on top of a scratch on a silicon wafer. The nanotubes were grown by researchers in the Department of Electronic Materials Engineering.

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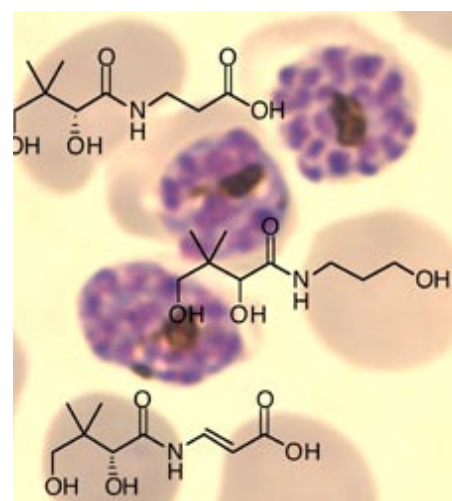
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Starving out malaria

Malaria is caused by a single-celled micro-organism that invades the red blood cells of its vertebrate hosts. It's an infectious disease affecting millions of people around the world and causes approximately one million deaths every year. According to the World Health Organisation, malaria is a major constraint to economic development, and the gap in prosperity between countries with malaria and countries without malaria is continually growing.

Dr Kevin Saliba and Professor Kieran Kirk at the School of Biochemistry and Molecular Biology are looking at ways for controlling the malaria parasites by starving them of vitamin B₅.

"With the emergence and spread of malaria parasites that are resistant to most of the antimalarial drugs that we currently have available, there is an urgent need to develop

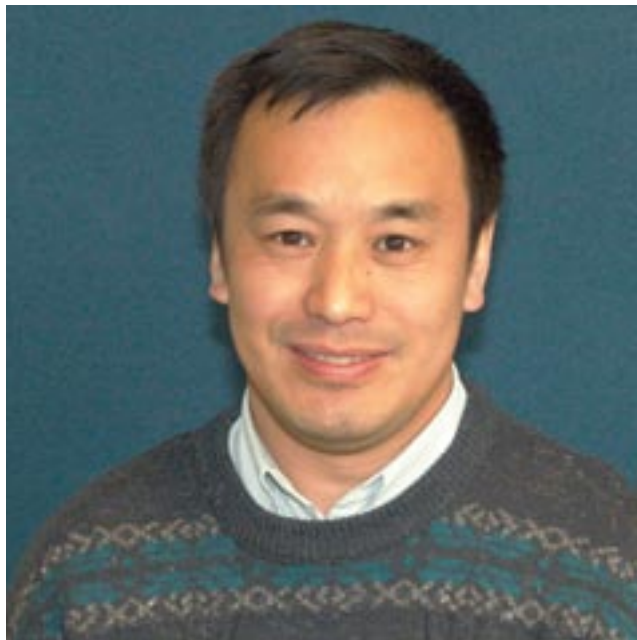


The image above shows malaria parasites (stained purple) residing within the red blood cells of its human host. Vitamin B₅ (the top molecule) analogues were shown by the scientists to kill the parasite and may provide the basis of a new antimalarial drug.

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contains both the carbon source and the metal catalyst required for carbon nanotube growth) is ground up in a ball mill for 100 hours (at room temperature in argon gas at a pressure of 300kPa). The argon



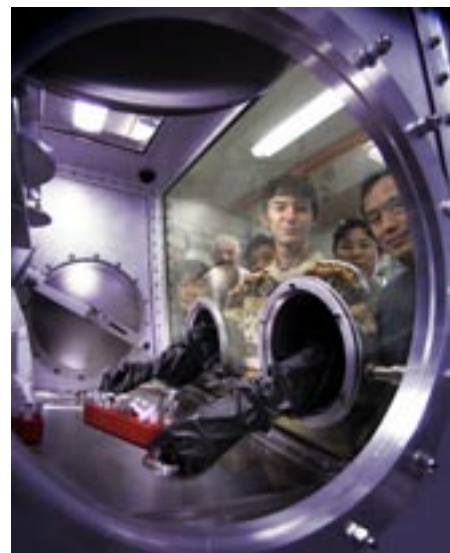
Dr Ying Chen

prevents oxidation during the milling process.

The milled sample is then placed in a quartz furnace next to a silicon wafer with a pattern scratched onto it using a diamond pen (in this case the letters A, N and U). The milled powder is then heated converting it into a vapour which is then carried in a stream of argon to be deposited on the wafer. Further heating results in carbon nanotubes growing from the scratched portions of the silicon wafer but nowhere else on the wafer.

When examined with a transmission electron microscope the nanotubes were shown to be multi-walled cylinders measuring some 50 nanometres in diameter.

"The selective growth of the carbon nanotubes over the scratched surface on the silicon substrate is a typical self-



Dr Ying Chen's team at Electronic Materials Engineering. The researchers have found a way to grow patterned nanotubes on a silicon wafer.

assembly process possibly driven by capillary force," says Dr Chen. "The successful selective growth on complicated patterns such as the three letters of A, N and U is an important step towards building nanotube devices."

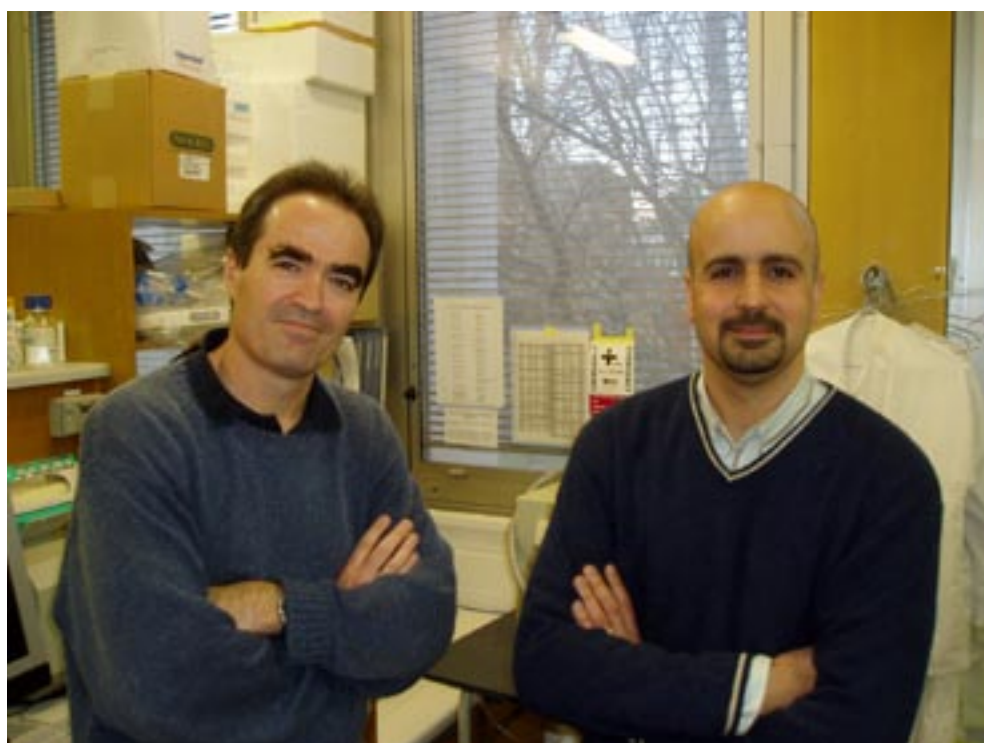
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new strategies to kill the parasite" says Professor Kirk.

It has been known for a long time that in order for malaria parasites to survive within the red blood cells of the human host they need to acquire vitamin B₅ from the blood plasma. Interfering with the parasite's ability to use vitamin B₅, therefore, represents an attractive way by which malaria parasites might be eliminated.

The scientists have identified two compounds (provitamin B₅ and CJ-15,801), and, in collaboration with chemist Dr Christina Chai and student Christina Spry, synthesised several others which are structurally similar to, but functionally different from, vitamin B₅ so they cannot work as vitamin B₅ in malaria parasites. These compounds have been shown to be effective at killing malaria parasites by interfering specifically with the parasite's ability to utilise



vitamin B₅. These compounds are relatively non-toxic to mammalian cells, opening the door to using this class of compounds as antimalarials.

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Dr Kevin Saliba and Professor Kiaran Kirk at the School of Biochemistry and Molecular Biology