MARK LEONG

Graduate students measure a carbon nanobased integrated circuit in the carbon nanofab cleanroom at Peking University.

CHINA'S BLUE-CHIP FUTURE

The country publishes more articles in materials science than any other nation, but to reap the economic benefits it needs to apply this research.

BY PENG TIAN

China has ambitious plans to sustain its economy by creating new industries around advanced materials.

In the past 15 years, materials science, particularly areas such as nanomaterials, has become a major priority for policy-makers. China has been the most prolific publisher of papers in the field for more than a decade, but the growth in these publications since 2010 has extended its lead. According to data from the Web of Science, materials science papers almost tripled between 2006 and 2015 (see graph). One in every 10 papers by a Chinese researcher in 2015 was in materials science. Behind the dramatic rise in publications is substantial government funding and concerted efforts to recruit talented researchers.

As well as boosting the economy, new materials will bring advances in infrastructure development that will help house, employ and transport the country's 1.3 billion people. "Every sector of society demands more and better materials, from the military to healthcare," says Lee Shuit-Tong, a nanomaterials professor at Soochow University in Jiangsu province.

But, materials researchers say more resources need to be directed to the translation of basic research. Without adequate support, China's attempts to commercialize materials research will be delayed, applied scientists say.

"APPLIED RESEARCHERS DO NOT GET A FAIR SHARE OF RESEARCH FUNDING."

CUTTING-EDGE SCIENCE

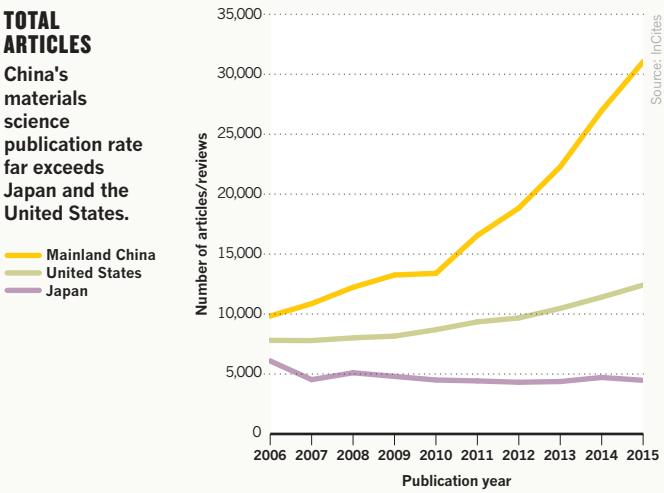
Significant investment in materials science is a major plank of China's wider science and technology strategy. The central government's national R&D plan, released in 2016, promises generous funding for research fields that are vital to the country's development, such as agriculture, or strategic fields that will boost its industrial competitiveness. The aim is to not only "catch up in the traditional advantage areas of advanced counties" such as high-performance alloy and steel research, but also to lead the world in rising fields, says Lee. One of the first such fields to be targeted by the government is nanotechnology.

In February, just before the opening of China's National People's Congress, officials in the Ministry of Science and Technology (MOST) promoted some fruits of its investment so far. In the past year, Chinese scientists created an iron-based superconductor, a super-strong alloy and a carbon nanotube transistor with a gate length of just five nanometres.

The tiny transistor was built by physicist Peng Lian-Mao and his team at Peking University in Beijing. Peng's lab has for years been

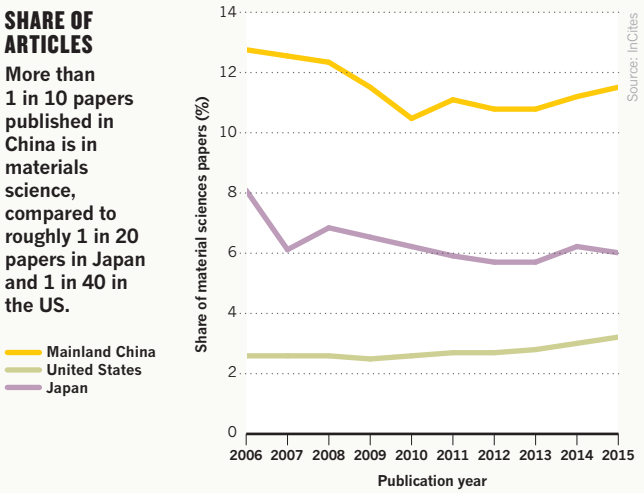
TOTAL ARTICLES

China's materials science publication rate far exceeds Japan and the United States.



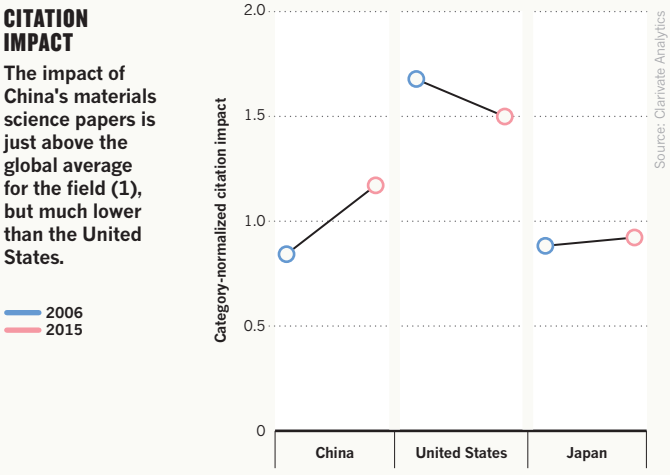
SHARE OF ARTICLES

More than 1 in 10 papers published in China is in materials science, compared to roughly 1 in 20 papers in Japan and 1 in 40 in the US.



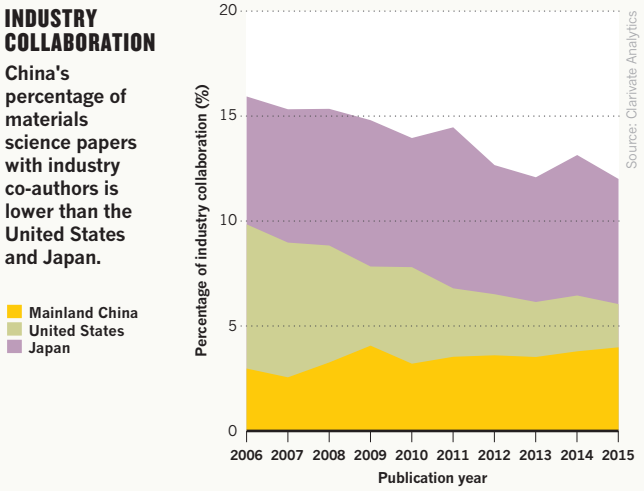
CITATION IMPACT

The impact of China's materials science papers is just above the global average for the field (1), but much lower than the United States.



INDUSTRY COLLABORATION

China's percentage of materials science papers with industry co-authors is lower than the United States and Japan.



developing technology to build ever smaller semiconductor devices and integrated circuits with carbon nanotubes — the future of computer processing. Models suggest that microprocessors made from carbon nanotubes could be ten times faster and more energy efficient than silicon chips.

Peng's transistor with a five nanometre gate, published in *Science* in January, was made possible with funding from MOST, the National Natural Science Foundation of China, and the Beijing Municipal Science and Technology Commission. As part of the government's key nanotechnology project, Peng's lab will receive about another RMB 32 million (US$4.6 million) over the next five years.

MORE APPLIED SCIENCE

The money is letting Peng's team do good work, but he says a greater portion of funding should be directed to applied research to enable groups like his to develop prototypes of their nanotechnologies.

"Applied research is innovative and requires long-term investment and effort, but applied researchers do not get a fair share of research funding," he says.

For instance, the key nanotechnology project budget offers basic science groups more than double the amount awarded to Peng's lab, with some groups given RMB 90 million (US$13 million) over five years. Developing carbon nanotube devices into computer chips will require "billions of RMB to build infrastructure, buy equipment and recruit highly-skilled people," he says. "Universities cannot do that."

> "IF WE PUSH AHEAD ONE OR TWO MORE STEPS, THE STATE MAY PAY ATTENTION AND A STATE-OWNED COMPANY WILL WANT TO WORK WITH US."

Peng says the central government has the money and determination to fund the entire development chain of new materials, from the laboratory to products on the market. But, he believes policy inertia and the influence of some authoritative scientists have skewed the funding towards basic science.

He says when projects have strong government support and funding, big companies or China's state-owned enterprises are more likely to invest in their technologies and help commercialize them.

Peng is confident that carbon nanotube chips will be fully developed in five to ten years. As well as his group, several teams around the world are making strides in this direction. For Peng to further develop his technology and produce chips on an industrial scale he needs a company to collaborate with. "Engineering is not what [my lab] is good at," he says. "But if we push ahead one or two more steps, the state may pay attention and a state-owned company will want to work with us." ■