Driving a materials economy

Materials research has long been highly active in China and could offer advanced technologies to boost the economy.

China's government has invested heavily in science in recent years: an estimated US$41 billion will be spent in 2016, approaching the approximate US$76 billion planned for the United States[1,2]. Materials science will receive a significant proportion as it provides a high-profile stage on which China's researchers can engage in cutting-edge studies. Moreover, it enables advances in infrastructure development — key for a developing country such as China that needs to achieve a standard of living in remote villages and towns that is on par with the big cities — and delivers technologies for domestic and international consumption. Materials have historically been highly studied in China, with investment and research output ever increasing[3,4].

In this issue of *Nature Materials* we take a closer look at some of the most active areas of materials research in China. Starting on page 688, several experts discuss the state of their research fields, including high-pressure research, thermoelectrics and condensed-matter physics, for which China has a long history and considerable expertise. Pieces are also contributed from those involved in advanced techniques, for example, computational approaches to materials research, electron microscopy and China's new spallation neutron user facility. Efforts towards commercializing graphene research are also featured. In an interview on page 699, Ke Lu, director of the Shenyang National Laboratory for Materials Science, discusses metallurgy, perhaps China's oldest and best-established materials discipline (see Fig. 1), and materials science in China.

Much has been said about China's economic development, including growth in 2015 being the slowest in 25 years (although the increase in gross domestic product was 6.9%, an eye-watering figure for most nations). While multiple avenues are being pursued, materials could help to spur certain quarters of the economy. And government policy aims to do just this: the most recent five-year plan highlights new materials and manufacturing as key areas for development. The Made In China 2025 strategy[5] was likewise advocated in this dossier: announced in May 2015, it aims to reform manufacturing to move towards high-end processes and complex materials.

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Figure 1 | Ancient Chinese metal workers have long had the capability to produce exquisite pieces, as demonstrated by this bronze cast ceremonial vessel from the Western Zhou dynasty, dated 1000 BC.

Indeed, manufacturing in China is going through a renaissance. Not long ago, the country had to import many of the advanced materials required to bolster the rapid growth of its infrastructure, whereas they can now be produced domestically at reduced cost — high-quality pipeline steels being just one example. The phrase 'made in China' was once an indictment of cheap goods of questionable quality; in contrast, a company in China recently demonstrated a fully flexible smartphone with a graphene display, the first of its type[6], while the first commercial jet designed and built entirely in China (Comac C919) has been unveiled. These few examples serve to demonstrate how manufacturing in China has come on in leaps and bounds, enabled in part by new materials insight.

A move towards such high-end products is not only desirable but necessary. A rapid rise in living standards has resulted in increasing labour costs, causing many manufacturing and assembly centres to relocate to central and southeast Asia, also driven by the government's encouragement of greener manufacturing to abate rising pollution levels in cities. As such, economic growth based on cheap labour can no longer be relied upon, and China must gain a new edge by establishing itself as a geographical centre for advanced technologies. Innovation is thus critical and China fortunately has no shortage of talented and ambitious scientists and engineers, enhanced by the return of thousands of Chinese scientists educated and trained overseas via the Thousand Talents Program. In addition, a framework for nurturing and progressing nascent research from lab to industry is needed, and China has done much to promote this. For example, at a time when some were criticizing the UK for not taking firmer action to commercialize its expertise in graphene[7], China was establishing an organization (http://www.graphene-alliance.com/) to facilitate the transfer of graphene research from lab to industry.

China's government has encouraged new materials-based technologies, which could reap financial rewards. Yet it must not be forgotten that truly innovative technologies often stem from blue-skies research, requiring scientists to have time, freedom and funds to pursue ideas that probably offer no short-term payoff. Only 5% of China's research and development expenditure is on basic research (compared to 18% in the United States)[8], with 80% of Chinese scientists interviewed by Nature Publishing Group for an independent analysis believing that more should be spent[8]. Although the time frame may be long, the next generation of materials-based technologies may come from speculative research, funding for which should be balanced against technologies that offer more immediate returns. Nevertheless, the ground work is being laid and new technologies are already coming to market, proving that materials can continue to drive China's powerhouse economy. ❐

References

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