Executive summary

Over the past 2 decades, the number of nanoscience-related scientists and academic output has proliferated. The academic impact of nano-publications has steadily risen.

This book presents an evaluation of nanotechnology-related academic publications and patents from 2000 to 2019, focusing on nanotechnology's influence on basic scientific research and industry. The assessment shows research funding and international collaborations in nanoscience to be the driving forces of nanotechnology developments. The book's findings are based on literature citation, research analysis, funding, and patent data sources from Elsevier's Scopus database, SciVal, Funding Institutional, and PatentSight. The following are chapter highlights from this book.

Research efforts related to nanoscience rapidly increased over the past 2 decades.

(1) There were 1.42 million research publications on nanoscience, involving 2.21 million researchers.

The approximately 1.42 million nano-related academic publications accounted for 4.2% of publications worldwide between 2000 and 2019, according to Scopus. At the same time, 5.2% of total publication authors, about 2.21 million researchers,[1] published articles in the field of nanoscience.

(2) The scholarly output in nanoscience had an annual growth of 14.6% in the past 2 decades, which was 3.2 times the rate of global publications.

Globally, the number of nano-related publications (nano-publications) increased from 11,555 in 2000 to 153,455 in 2019,

[1] Researcher count method: This is based on the unique author IDs in Scopus, which are used as a proxy in calculating the number of researchers.

accounting for 1.1% and 6.2% of total annual academic publications, respectively. The compound annual growth rate (CAGR) for nano-publications was 14.6%, which was 3.2 times that of worldwide publications.

Meanwhile, the number of authors who published nano-related scholarly output increased from 32,591 in 2000 to 498,948 in 2019, accounting for 2.5% and 10.9%, respectively, of authors worldwide. The CAGR of nanoscience-publishing authors between 2000 and 2019 was 15.4%, which was 2.3 times that of global authors.

The field-weighted citation impact (FWCI) score of nano-publications in China and worldwide was rising, indicating a stronger academic impact in the field of nanotechnology in these areas.

(1) The FWCI of nano-publications was 1.6 times the global average.

For all global publications, the FWCI is benchmarked to 1. Between 2000 and 2019, the FWCI of nano-publications was 1.6. Nano-publications from China exhibited a significant increase in FWCI, shifting from 1.3 in 2000 to 1.9 in 2019, a growth rate of 43%. In 2019, China surpassed the United States' FWCI score in nanoscience.

(2) Among the top 1% highly cited publications, 11% were nanoscience-related, even though nano-publications accounted for only 4.2% of the global literature.

Over the past 2 decades, 11% of the top 1% highly cited publications were nano-publications. The total grew from 4.2% in 2000 to 13.6% in 2019, reflecting the essential contribution of nano-research in some of the most highly impactful studies.

As an interdisciplinary field, nanoscience served as a comprehensive platform for the integration of basic research, contributing to multiple fields and advancing scientific development.

(1) Nano-publications appeared most frequently in the subjects of materials science, chemistry, physics and astronomy, and energy.

Over the past 2 decades, the percentage of nano-publications has increased in multiple fields, especially in materials science. From 2000 to 2019, over 10% of studies in four research subjects were relevant to nanoscience. These subjects were materials science (20.7%), chemical engineering (17.7%), chemistry (16.3%), and physics and astronomy (12.8%). With 11% of its publications in nano-research, energy was added to the list for 2010−19.

(2) The fastest-growing subfields were in nanobiology.

In immunology and microbiology, the CAGR of nano-publications was 5.1 times that of all publications in the same field in 2000−19. This figure was 4.4 in the subfield of biochemistry, genetics, and molecular biology and 4.0 in the subfield of pharmacology, toxicology, and pharmaceutics. Despite the rapid growth, the volume of nano-publications in life sciences is still relatively small.

Nanoscience is closely related to the most prominent research topics.

(1) Nanoscience has covered some of the hottest issues in science.

Of the most prominent research topics[2] between 2015 and 2019, 89% had at least one publication related to nanoscience and 39% had strong connections to nanoscience: that is, at least 10% of their publications were nano-related. The data showed that nanoscience was tightly integrated with many emerging research fields.

(2) Among all fields, nanoscience had the closest connection with highly prominent topics in physical sciences.

Between 2015 and 2019, in the below 5 subjects - material science; physical and astronomy; chemistry; chemical engineering; energy; and pharmacology, toxicology and pharmaceutics - there were at over 42% of the most prominent topics strongly related to nanoscience, with at least 10% of the topic's publications being nano-related.

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[2] The most prominent topics: These are topics whose topic Prominence score ranks among the top 1% in the world. See Chapter 2 and the Appendix for the topic significance score.

(3) Nanoscience focused on certain prominent topic clusters.

Between 2015 and 2019, nanoscience had the highest scholarly output in the highly prominent topics clusters[3] of solar cells, graphene, lithium batteries, plasmon metamaterials, biosensors, catalysts, semiconductor quantum dots, nanoparticles, and polymers.

Compared with China, the United States, Germany, Japan, and the United Kingdom had a higher academic–corporate collaboration rate[4] in nano-research, and patents frequently cited their results.

(1) In nanoscience, the United States, Japan, Germany, and the United Kingdom have a more extensive academic–corporate collaboration than does China.

Between 2015 and 2019, both China and the world had academic–corporate collaboration rates in nano-research that were slightly lower than the overall national and global averages, respectively. The United States, Japan, Germany, and the United Kingdom had higher rates than China, demonstrating more frequent collaboration between the academic and corporate sectors in these countries.

(2) The percentage of nano-publications cited by patents was higher than average.

Between 2015 and 2019, 1.04% of global nano-publications were cited at least once by patents filed under the largest five intellectual property offices.[5] This figure was 89% higher than the world average of 0.55% for all publications.

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[3] Topic clusters with Prominence scores that rank in the top 5%.

[4] Academic–corporate collaboration rate: Literature copublished by authors from both academia and industry is referred to as academic–corporate collaborated publication. The ratio of academic–corporate collaborated publications to all publications is the academic–corporate collaboration rate.

[5] The largest five intellectual property offices: World Intellectual Property Organization, the US Patent and Trademark Office, European Patent Office, Japan Patent Office, and United Kingdom's Intellectual Property Office.

The five offices recorded an average of 10.4 citations per 1000 nano-publications. Of China, the United States, Germany, the United Kingdom, and Japan, the United States had the highest rate, at 23.7 citations per 1000 nano-publications, and China had 6.0.

(3) Nano-related patents from China have been proliferating, but China's patent competitiveness has room for improvement.

In the past 2 decades, there were about 690,000 nano-related patents worldwide, according to data from the patent analysis platform PatentSight. The percentage of nano-related patents grew from 0.9% in 2000 to 3.8% in 2019. Among those nano-patents, 58% came from China. Although the country has the largest number of nano-related patents, there is room for improvement in its competitiveness.

Among the projects funded by major global funders, the share of nano-related grants continued to increase.

(1) The share of nano-related awards was rising.

According to the funding database Funding Institutional, 132,220 awards were granted to nanoscience-related projects between 2009 and 2018. The number accounted for approximately 3.6% of all global awards in the database, and the CAGR was 3%. Although the total number of grants in that period remained the same, the proportion of nano-related projects increased from 3% in 2009 to 4% in 2018.

(2) Materials science received the highest share of nano-related awards.

Among the fields of science, materials science received the most grant awards for nano-research. Between 2009 and 2018, 29.4% of awarded grants were relevant to nanoscience in materials science, followed by 17.9% in physics and astronomy, and 14.8% in chemistry.

The degree of international collaboration in nanoscience was higher than the average for all research fields.

(1) The international collaboration rate in nanoscience was higher than all research fields combined.

Between 2010 and 2019, the international collaboration rate in nanoscience was 25%, with a total of 277,793 nano-publications published by collaborating authors from different countries and regions. The worldwide international collaboration rate over that period was 21%, indicating more frequent international cooperation in nanoscience.

(2) China has proven itself as a global ally in the nanoscience field.

China's international collaboration efforts in nanoscience have steadily risen, and at a rate much faster than those of other research disciplines in the country. Meanwhile, internationally collaborated nano-research with China as a partner exhibited a high academic impact: between 2010 and 2019, international nano-publication collaborations from China had an FWCI of 2.5, a higher score than those of other countries such as the United States (2.3), Japan (1.8), Germany (1.8), and the United Kingdom (1.9).